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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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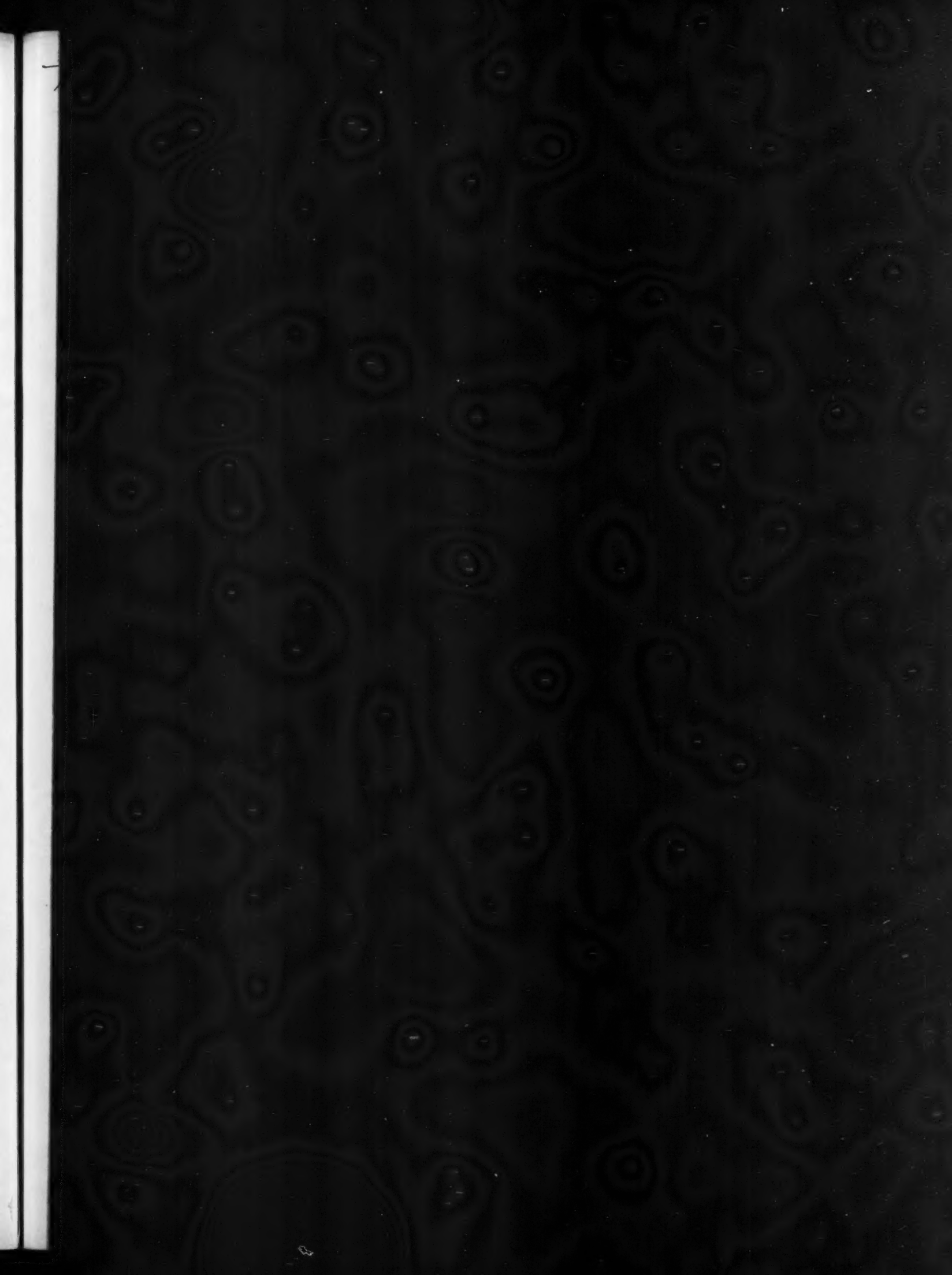

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VOLUME XXVIII SAN FRANCISCO, JANUARY 6, 1912 NUMBER 1

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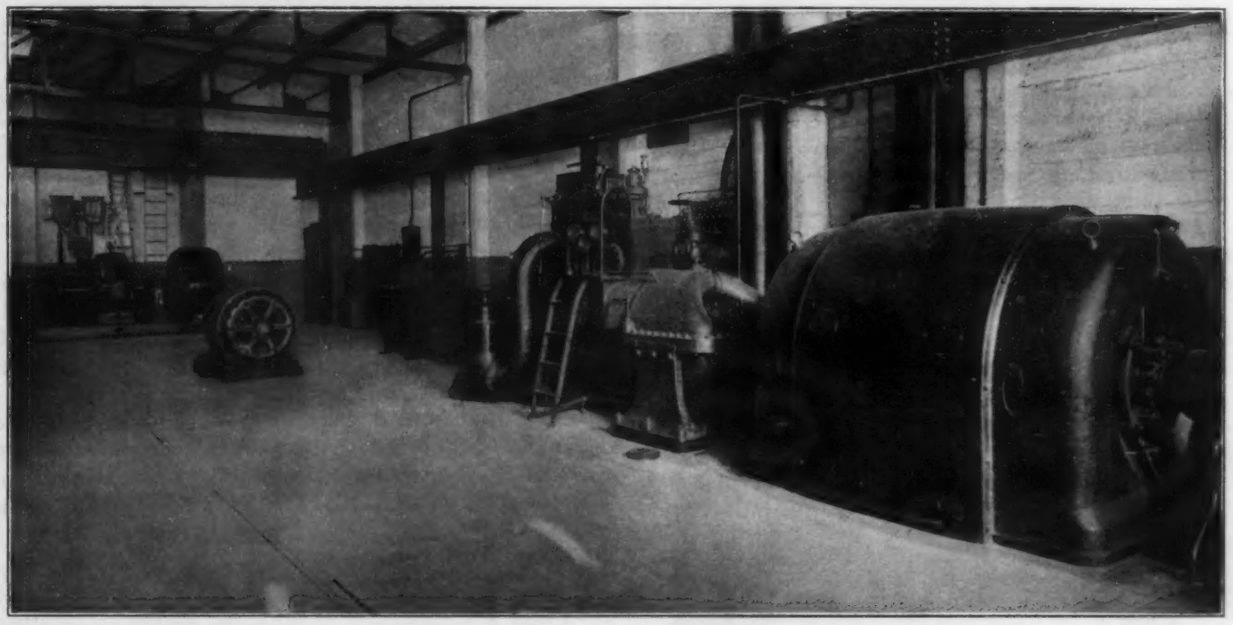
UNITED LIGHT AND POWER COMPANY

BY J. G. DEREMER, V. P. AND CHIEF ENGINEER

The United Light and Power Company is handling three combination steam and electric supply stations at San Francisco in such a unique and distinctive manner as to make the operating methods of great engineering interest. This company controls and operates the Consumers Light & Power Company, the Equitable Light & Power Company and the Southside Light & Power Company in San Francisco, as well as the Central Oakland Light & Power Company in Oakland, California. This article will deal only with the San Francisco companies.

These companies are generating and distributing electric power at 220 and 110 volts, direct current; energy for lighting at 220/110 volts, two-phase, alternating current; and low pressure steam for building heating, water heating, and for kitchen use at from 1 to 6 lb. pressure. The three stations, as well as their distributing systems, both steam and electrical, are most intimately interconnected. The system of networks gives great flexibility and allows a novel method of operation which will be developed after the several plants are described.

The generating plants of the companies are situated as follows: the Consumers Light & Power Company in the Whitney Building, the Equitable Light & Power Company in the Phelan Building and the Southside Light & Power Company in its own building adjacent to the Rialto Building, on Minna street. The Consumers plant is designed for direct current power generation only, the engines all exhausting into the steam heating system. The other two plants are designed for alternating current generation and are equipped with condensers and cooling towers so that the turbines may exhaust either into the steam heating system or into the condensers.

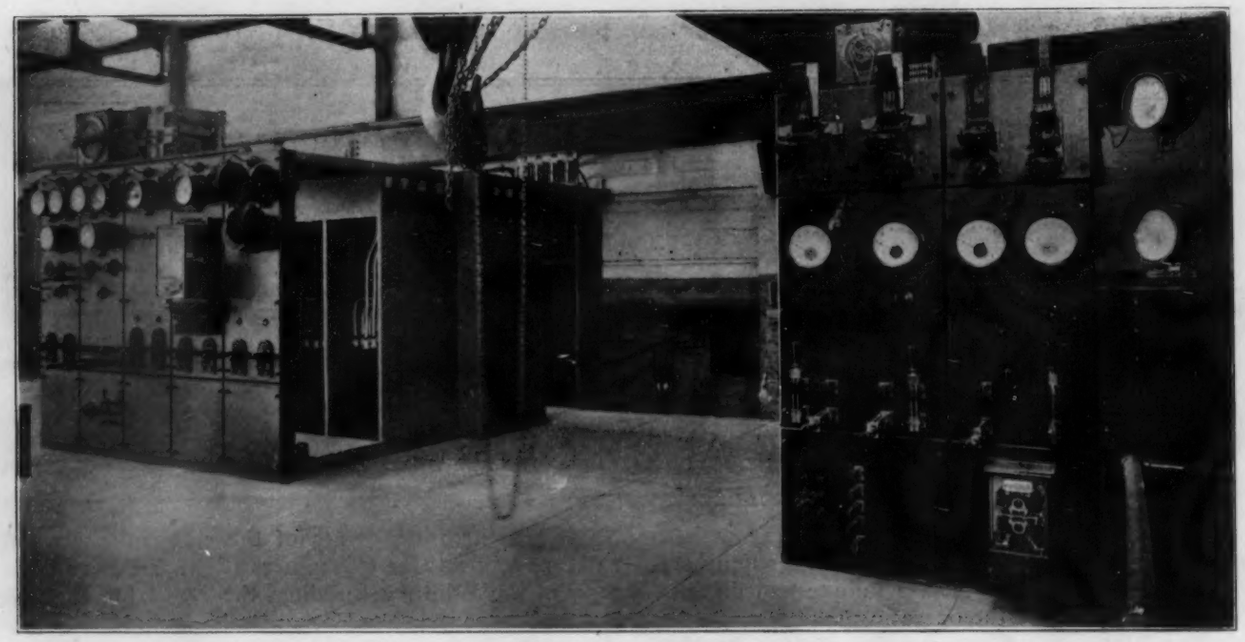


Turbine at Southside Plant.

Plant Equipment.

The Consumers plant consists of Franklin and Stirling water tube boilers, American ball angular compound reciprocating engines, and Westinghouse direct connected, 3 wire, direct current generators. The switchboard is of standard Westinghouse design.

The Equitable plant consists of Stirling water tube boilers, Westinghouse-Parsons turbo generators and Westinghouse switchboard. There is, in this



Switchboard at Southside Plant.

plant, a synchronous motor-generator set by means of which the direct current power system and the alternating current lighting system are tied together. This set is a novel feature of the electric system of which more will be said later. The plant is equipped with a turbine exciter set and a motor driven exciter set, and is also arranged for excitation from the d.c. power bus bars when necessary. The cooling tower for the condenser circulating water is on the roof of the Phelan Building.

The Southside plant consists of the same types of apparatus as does the Equitable. The plant construction is different, however, the turbines and condensers being supported by the steel framework of the building so that they are directly over and close to the boilers. The cooling tower is on the roof of the Rialto Building. The motor generator here is an induction set

Each of the above stations is equipped with fuel and water storage tanks and the usual fuel and feed water pumping sets. The plants in the Whitney and Phelan Buildings are equipped with ventilating fans to provide the necessary fresh air and keep the temperature normal.

Boilers at Southside Plant.

Electric Distribution System.

These three generating stations are electrically interconnected with suitable high tension and direct current cables so that the load may be carried by whatever units the engineers may choose to operate, or by the station upon which the steam system may be making heavy demands.

From each of the stations feeders radiate to the principal streets of the downtown business section. These feeders are frequently interconnected so that they form a very flexible and well balanced distribution system. The high tension system feeds standard Westinghouse manhole type transformers at 2400 volts. These transformers are banked together on the low tension side wherever possible.

The direct current feeders are run out from the Consumers station, and the motor generators of the other two stations are tied in directly with this station. Interconnection at various manholes, together with the above three sources of supply, further enhances the flexibility and balance.

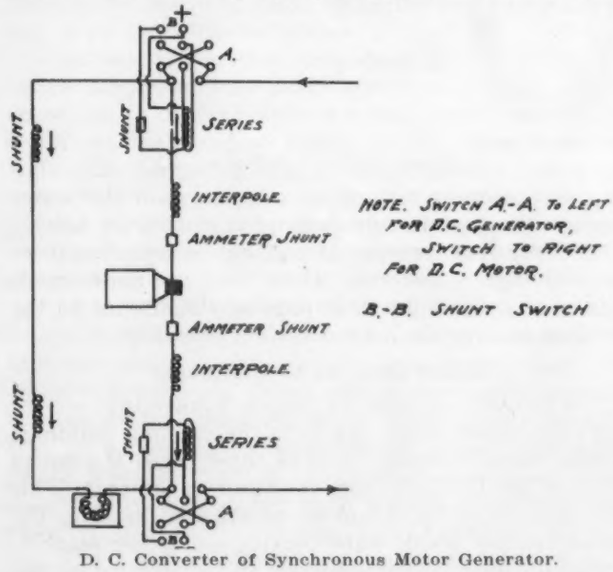
In addition to the flexibility existing in each of the above systems there is obtained a very interesting and useful combination of operation between the two systems through the synchronous motor generator set at the Equitable station. During the late night hours this set carries the power load alone, the Consumers station being shut down. During the peak hours in the early evening this set generates alternating current, operating in parallel with the turbines. This method of operation permits both the Consumers and the Equitable stations to carry full load on all units before it becomes necessary to call upon the Southside station for assistance. The labor expense is thereby reduced.

Considerable interest centered about the operation of this set in parallel with the turbines. It was at first found that, due to the poorer regulation of the

Turbines at Equitable Plant.

reciprocating engines in the Consumers station and to the fluctuation of the power demand, the motor generator, when generating alternating current, was inclined to take the load away from the turbines. This would result in opening the circuit breakers on the direct current side of the set, thus cutting the alternating current and direct current systems apart.

By the installation of double-throw switches, as shown in the accompanying diagram, the series fields

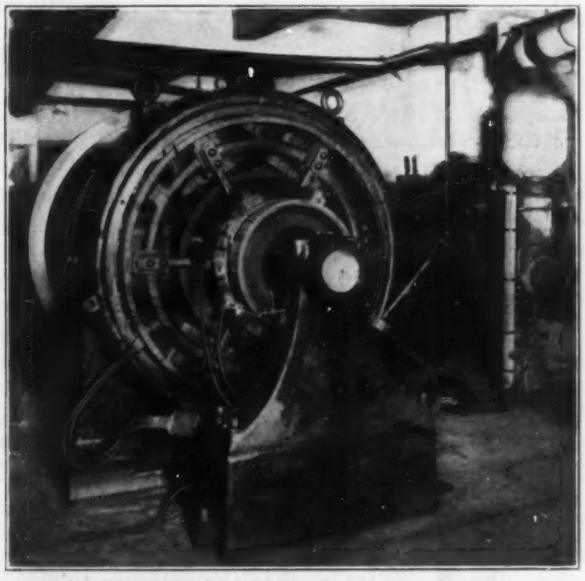


D. C. Converter of Synchronous Motor Generator.

of the direct current motor were made reversible. When it is desired to operate the machine as an alternating current generator the double-pole double-throw switches shown at AA are thrown to the right. This makes a regular compound wound motor, the field flux of which increases with increased load. The counter electro-motive force of the motor increases correspondingly and this tends to decrease the speed and consequently reduces the load on the motor. In this way the motor generator set will carry its full load in parallel with the turbines and does not attempt to take more than its share. In fact, the variation in the alternating current meters on this set is no greater than the variation in the turbine meters.

When it is desired to operate the set as a direct current generator the double-throw switches are thrown to the left and the small shunt switch is closed, thereby giving sufficient compounding to enable the generator to share the direct current load equally with the engine driven generators at the Consumers station. In order that the polarity of neither the engine driven generators nor the motor driven generator be reversed, the proper amount of this compounding had to be very carefully determined as there were no equalizers between the two stations.

The existence of several stations combined with the resulting combinations of operation enables the companies to give a highly satisfactory service, the



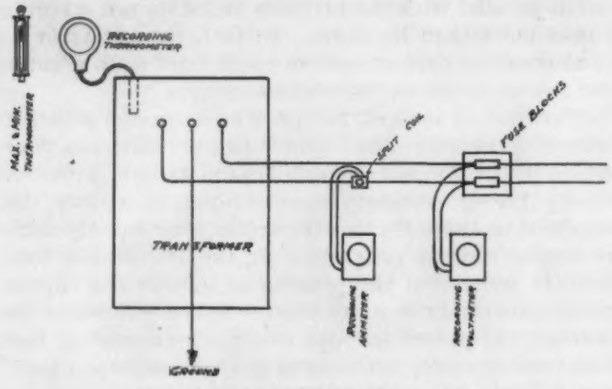
Parallel Compound Unit at Consumers' Plant.

voltage regulation in the entire system being practically perfect.

The manhole transformers on the alternating current system are subject to considerable variation in load throughout the year. In order to know that they are not overloaded twenty-four hour tests are occasionally made with the apparatus as shown in the accompanying diagram. A recording ammeter and voltmeter determine the load on the transformer while a recording thermometer indicates the oil temperature and another the manhole temperature. Simultaneous readings of all necessary data are, therefore, had for any instant of the twenty-four hours, and a complete study of the transformer's behavior may be made.

Steam Distribution System.

The generating stations are interconnected with low pressure steam mains of the American District Steam Company's standard construction. These mains are largest at the stations, gradually diminishing in size as they approach the more remote districts. These lines are interconnected at various manholes so that a network of steam distribution in general paralleling the electric distribution system, enables the



Transformer Recording Apparatus.

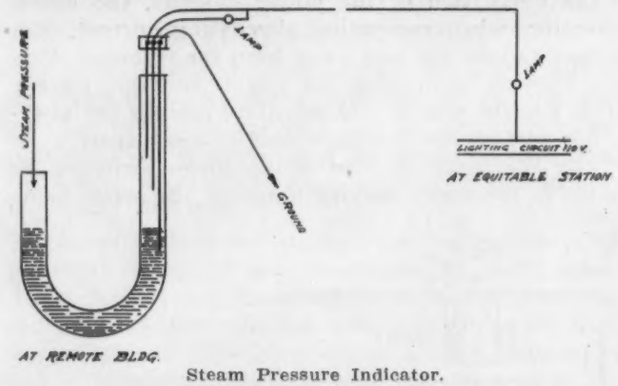
companies to serve buildings with both electricity and steam. The steam mains were laid in the same trenches with the electric ducts. A tin lined, wood casing surrounds the steam piping with a sufficient air gap to insure minimum radiation. Expansion and contraction is accommodated by devices known as variators. These variators are absolutely perfect in their operation, there having been no failures or leaks since the system was installed. Parts of the system have been in operation for a period of three years. During this time there have been no interruptions to service and practically no repairs have been made on the entire system.

As the steam demand varies with the temperature and weather conditions, it became necessary to know just what pressure to carry in the various stations so that the most remote buildings had sufficient steam. To accomplish this a steam pressure indicator was devised, as shown in the attached diagram. One small wire is used between the building at the terminal of the line and the Equitable station. The U-tube filled with mercury is placed at the building while the pilot lamp is situated at the Equitable station. Should the pressure fall below a predetermined amount, the middle terminal in the mercury tube will not make contact through the mercury to ground, and consequently the pilot lamp goes out. When the pressure is at the proper value the pilot lamp burns in series with a lamp at the building and thus gives about half candlepower. If, however, the pressure rises so that the mercury touches the upper terminal, the pilot lamp gives full candle power. The engineer has, therefore, to keep the pilot lamp burning dim in order to give all customers satisfactory service.

The operation of the steam distribution system is similar to that of the electric. As the load demand changes from the office buildings during the day to the hotels and apartment houses during the evening, it is supplied by the station which will give the most satisfactory service and fortunately this is usually the station upon which the heaviest electric demand is at the time being made.

Gate valves are installed at all intersections and are useful in regulating the pressure on various portions of the system; it being possible to increase or reduce the pressure on almost any line of the system at will.

Steam is supplied by the companies not only for heating radiation but for heating water, steam tables and the usual kitchen apparatus as well as for certain manufacturing processes. The companies install water heaters of their own manufacture and in such a



Steam Pressure Indicator.

way as to permit continuous circulation of the water through the heater, thus keeping it constantly hot.

All services are trapped and the condensation from the buildings is metered. Data from the meter readings is of great value in improving the service to the building and regulating the system generally.

Steam Services to Buildings.

When the companies began connecting service pipes from their street mains to the existing buildings it was found necessary to run these pipes the entire depth of the building from the front to the rear. This was occasioned by the usual practice of locating the house heating plant, water heater and other machinery at the rear of the building. This location of the heater was probably found by the architects and builders to be more convenient for fuel delivery and usually more accessible for the house chimney. The kitchen of the hotel is also in the rear and the cook or handy man, janitor, or whoever acted as fireman was thus near the mechanical center of the building.

With the advent of central station steam this center of distribution for the building has become unsuitable. The cost of making the service connection is high. The presence of a long run of pipe supported

Boilers at Equitable Plant.

Boilers at Consumers' Plant.

from the basement ceiling is often objectionable and frequently radiates heat where it is not only unnecessary, but sometimes undesirable. Further than this the length of piping being considerable, there is a corresponding loss of pressure when the building is drawing large quantities of steam.

In buildings erected since the coming of the street steam supply, arrangements have been made mutually agreeable to owner, contractor and central station, to terminate the building piping at the front retaining wall. The foregoing objections are thereby overcome, and usually an actual saving to the owner is made possible. It is felt that the value of this point cannot be over-estimated by those interested in building construction.

In buildings equipped with high-pressure steam-driven machinery, the use of central station low-pressure steam is easily made by adapting such machinery for electric drive. Steam hydraulic elevator equipment, for instance, can be served by the installation of a motor-driven centrifugal pump with automatic pressure control. The other utilities are even more easily substituted with electrically-driven machinery.

The Westbank Building is an apt example of what may be accomplished in this field. Here the hydraulic elevators, the air compressor, vacuum producer, kitchen fuel oil, and roof-tank pumps were all changed from steam to electric drive and the labor item completely eliminated, the fire risk diminished, and a very desirable day electric load created. The elevator motor and pump are of especial interest. A direct current interpole type motor is direct connected to a Byron Jackson three-stage centrifugal pump operating at 1700 r. p. m. The design of the pump is such that at 150 lb. hydraulic pressure it will have zero capacity; i. e., will simply churn the water, while at 125 lb. pressure it will deliver full-rated capacity, and at still lower pressure a greatly increased output. It is thus suitable for hydraulic elevator supply since the cars often start together, thereby demanding a sudden rush of water, but at reduced pressure. The motor control used is the multiple unit switch field resistance type controlled by a master relay. The pressure regulation is effected by an air compressor type electric limit switch.

Steam Heating From Central Stations.

The practice of supplying the buildings of a large city with steam heat from street mains fed by a central supply station, or group of stations, is a comparatively new one. The losses due to radiation and leakage were formerly so enormous that the cost of such service became prohibitive. The recent development by the American District Steam Company of their superior method of insulation and their expansion devices has not only made possible the supply of steam heat from a central station, but this steam can be supplied at low pressure so that it may be taken directly from the exhaust of engines and turbines, after having given up a part of its energy for the generation of electricity. It has thus become practicable to unite these two important public utilities—electricity for lighting and power, with steam for heating and cooking purposes.

While it is evident from the above technical discussion of the companies' plants that this combination operation is actually being carried on, the writer has made the foregoing recapitulation for the purpose of drawing a few interesting analogies.

The remarkably successful operation of this type of steam distribution and the very encouraging reports of eastern systems that have been in operation for a

longer period of time, insure that this is certain to be a permanent factor in the public utility life of San Francisco. It will be of interest to note some of the reasons for the rapid growth of the heating business.

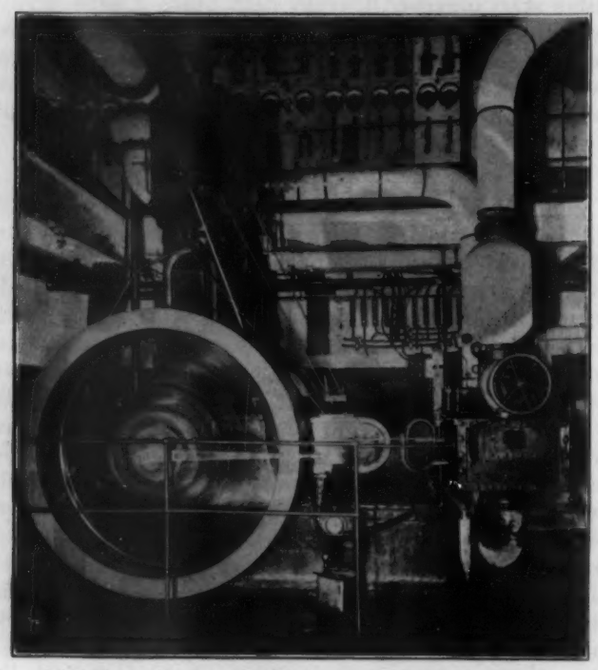
In ages past the public was accustomed to go over to the town pump for its water; to pour its own candles for light; and to go into the forests or mines and obtain its own wood or coal for heat. Then came the tank or cistern and the pump in the back kitchen; also the kerosene lamp; and the basement furnace, or steam boiler.

Later the water company was formed. It piped the building and provided the necessary pressure to insure a continuous supply of water wherever desired and without exertion other than the turning on of a faucet. Then came the gas and electric light companies locating their light at will and making it constantly available. Now comes the remaining utility —heat—in constant readiness at the mere turning of a radiator valve.

Just as the new methods of water and light supply have displaced the old, so is the new heat supply to banish the old. The reasons are obvious and sufficient.

The first cost of a building heating plant is from $250 to several thousands of dollars according to the service to be given. This is entirely eliminated by the central station supply.

The labor of operation is avoided, and while this is usually combined with the janitor and house mechanic duties in one man, it is nevertheless an item of some moment. The recent passage of an ordinance by the San Francisco Board of Supervisors requiring



Angular Compound Unit and Switchboard at Consumers' Plant.

that any oil burning fire shall not be left without an attendant for a period greater than twenty minutes, adds increased importance to this labor consideration.

Then there is the fire risk. The entire absence of fire and fuel storage from buildings certainly materially lessens the danger from fire. While the Board of Fire Underwriters has not as yet seen fit to reduce the insurance rates in buildings heated from the street mains, it cannot fail to recognize this fact when the industry is older, more thoroughly investigated and better understood.

Other advantages as cleanliness, the absence of smoke from the numerous small chimneys, the uniform and continuous pressure of the steam supply day or night, and the demand service of an expert steam and heating engineer at all hours are best appreciated by those who have been obtaining the service for some time.

Regarding the cost of service and method of charging for steam heating; like the other utilities, water, gas and electricity, when first produced the steam service was contracted at a flat rate. This was based on the amount of radiation connected to the building piping. And, like the flat rate service of the other utilities, the steam flat rate charge is unsatisfactory and unjust to both consumer and central station, and more expensive to both.

By any method of basing it a flat rate charge per month or year cannot correctly remunerate a company for serving steam heat. If it is based on the radiation supplied, the charge then becomes a function of the architect's or heating contractor's ratio between square feet of radiation and cubical contents heated. This ratio varies from less than one hundred to more than one thousand, hence, a uniform charge per square foot of radiation may be ten times smaller or ten times larger than that of another building of similar size.

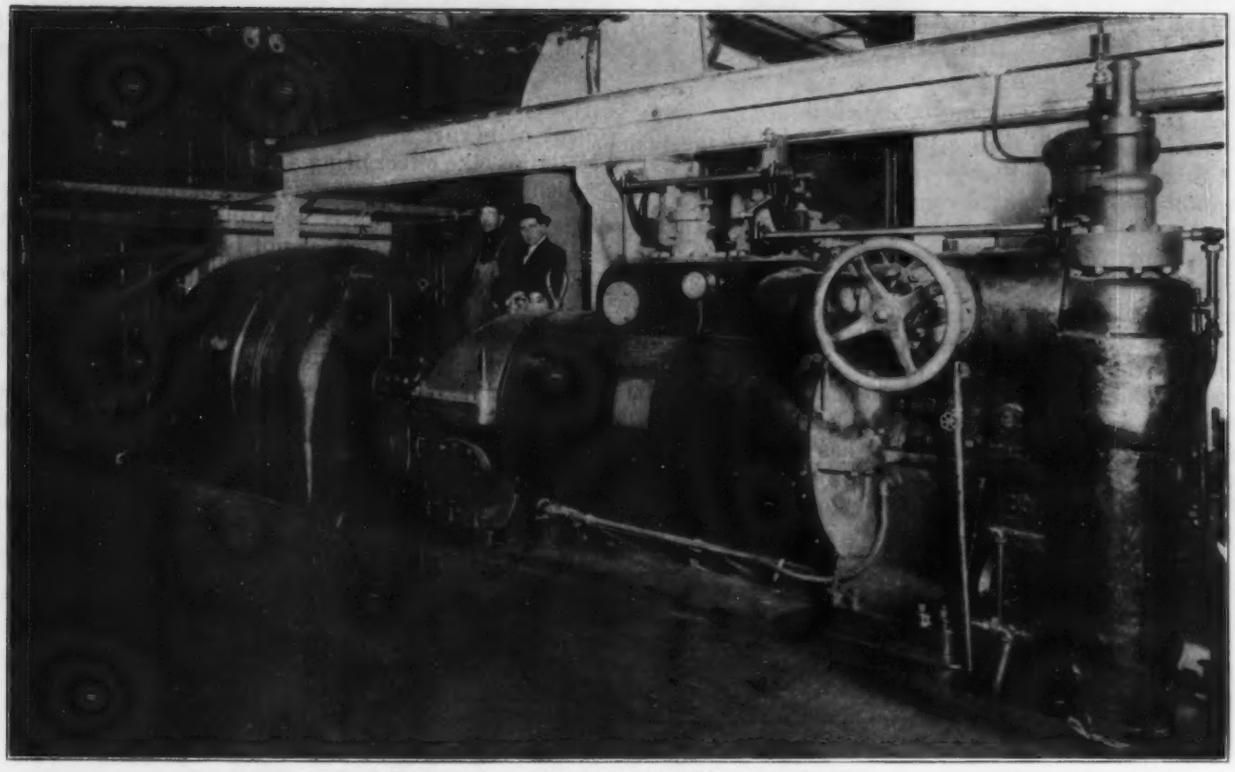
If the charge is based upon cubical contents the amount of radiation will again effect the result. If it is low the company will gain, if high, the consumer. And a hotel lobby constantly heated will pay no more than the upper floor of a furniture store which may be heated but once or twice a week.

These companies are, therefore, changing their method of charge to a meter basis. The condensed steam, or water of condensation, is weighed after passing through the building trap and before being thrown into the sewer. The meter used for this purpose is known as the simplex condensation meter. It accurately weighs and records the amount of water which has been condensed.

If, now, the charge for heating is based upon the number of thousands of pounds of water condensed, it is a direct payment for the heat used because a thousand pounds of steam at a given pressure always contains exactly the same amount of heat and a constant amount of this heat is given out when the steam condenses.

As with the other utilities with which comparisons have been made, there is an extravagant waste of steam when sold at a flat rate. From force of habit one will throw open the window when too warm, rather than turn off the steam and the radiators in unused rooms will be left going. Although entitled to all he may desire, the customer ultimately pays for this waste since no company can afford to serve steam heat at a loss. The extra fuel cost for this wasted steam is, of course, figured into the flat rate charge.

On the other hand, it has been found by those



Turbine and Switchboard in Equitable Plant.

companies which have changed their method of charging from a flat rate to a meter rate, that the consumption of steam in a building has been reduced often to one-half or less. Thus, while it may appear from the steam consumption, that if a customer were to pay the price demanded by the company per thousand pounds the bill would be double the existing flat rate bill, in reality it may be found that by a careful study of the steam consumption the bill by meter may be reduced to less than the flat rate bill.

These companies in bringing about the change to meter rates intend to send their experts among the various buildings to assist the customers in learning to economize their steam consumption.

The officers and engineers of these companies appreciate the fact that they are developing a new industry and they do not, therefore, profess to know or even predict what alterations and modifications of the service may be found to be advisable later. The public may be assured, however, that everything which experience proves to be possible will be done to give the most desirable service at the lowest cost consistent with conservative management.

GAS COALS.

With the idea of finding coals throughout the United States available for the manufacture of illuminating gas in order that they may be substituted for the higher priced and rapidly vanishing Pennsylvania gas coals, the Federal Bureau of Mines sometime ago completed a series of investigations which have just been embodied in a bulletin entitled "Coals Available For the Manufacture of Illuminating Gas."

"The annual drain on the gas-coal resources of this country and the importance of the gas and coke industries are indicated by the fact that 8,390,129 tons of coal were carbonized in retorts in the United States in 1909. The resulting salable products from by-product ovens were 15,791,220,000 cubic of coal gas, 6,254,644 tons of coke, and 60,126,000 gallons of tar. The total value of all by-product was $28,508,637.

"There are few well-developed coal fields in this country that furnish coal satisfying all the requirements of illuminating gas manufacture. Most of the coal used hitherto has come from Western Pennsylvania, the quantity supplied by other fields being relatively small. The introduction of gas coals from new or little-known districts has been difficult because of the lack of necessary testing stations and of scientific study of the complex process of gas manufacture."

Detailed tests of the coals from various parts of the country are given in the bulletin, which may be obtained free of charge by applying to the Director of the Bureau of Mines, Washington, D. C.

ELECTROLYTIC RECOVERY OF ZINC.

A new process for the electrolytic recovery of zinc has been successfully worked out by Mr. Chitaro Yoshida, the proprietor of a copper mine in Iwashiro Province, Japan. The zinc ore is dissolved in the electrolyte, and from this liquid the zinc is precipitated by electrolysis. The process is simple, but several obstacles have been found. For instance, the presence of a small particle of copper, antimony, or arsenic is enough to render the process futile. One of the defects of the process heretofore has been the spongy form of the zinc which adhered to the cathode. To prevent this, carbon was tried instead of lead in the anode. The carbon was coarse and dissolved in the sulphate of zinc, and the zinc which gathered on the cathode was then found to be refined to a degree rarely surpassed by the imported metal.

OTHER INDUSTRIAL APPLICATIONS OF OIL BURNING.

BY E. N. PERCY.

Lime and Cement.

Few engineers realize that nearly half of the fuel oil consumed is used for purposes other than the generation of steam; single cement companies taking as much as a thousand barrels a day and individual copper smelters more than this. Lime burning is now carried on with oil fuel exclusively where it is obtainable. Many different methods are used.

It has been found that when oil burners are applied to the ordinary kiln the outside is excessively heated while the center core of lime stone would be unburned. This is partly due to combustion taking place too close to the burner. It has been previously stated that the flame should not impinge upon anything, but this applied more particularly to boiler furnaces and a mental reservation was made as follows:

After atomization is thoroughly completed and the fuel has assumed a gaseous form and the admission of air is so distributed that the flame is long, soft, and slow burning without points of intense combustion, the flame may impinge upon and enter a white hot body of lump material having large interstices, such as lime stone, brick, etc.; but if the flame impinge upon such substances too close to the burner or before atomization is complete it will deposit carbon and oil and instead of entering the aggregate will be extinguished at the boundary lines. Therefore, in order to properly heat the center core of a lime kiln the admission of air should be distributed along the path of the flame so that it enters the aggregate after atomization is complete, but before combustion is complete. Good results can be obtained by the admission of stack gases into the furnace for the purpose of lengthening and softening the flame and so increasing the volume of hot gases that they must penetrate to the center core in order to find egress.

The upper part of Fig. 104 shows such an arrangement in which a steam siphon is used for abstracting the stack gases; in the plan will be noted two slide gates, one communicating with the stack, the other with the atmosphere and connected with a common lever. A movement of this lever gives any desired mixture of air and stack gases. It might be mentioned that an actual economy is effected by this system because of a very high temperature of stack gases.

The lower part of Fig. 104 shows the arrangement of burner and draft tube used with such an installation, the effect being a wide conical flame through which the draft passes. It will be noted that where the stack gas system is used the mixture can be admitted near the burner, it not being necessary to distribute throughout the length of the flame. The amount of mixture, consequently the amount of oxygen, is regulated by the steam siphon and the quantity of the mixture is controlled with the slide gates.

Lime burning has been carried on in many other types of furnaces, and as the greatest success has been obtained, prior to the introduction of oil, with weak producer gases rather than direct fuel it is easy to see why the stack gas method would have such beneficial effects. Some lime burners have obtained the same effect with an extremely heavy fire and insufficient air and lots of smoke, but this takes more oil and invariably discolors the lime.

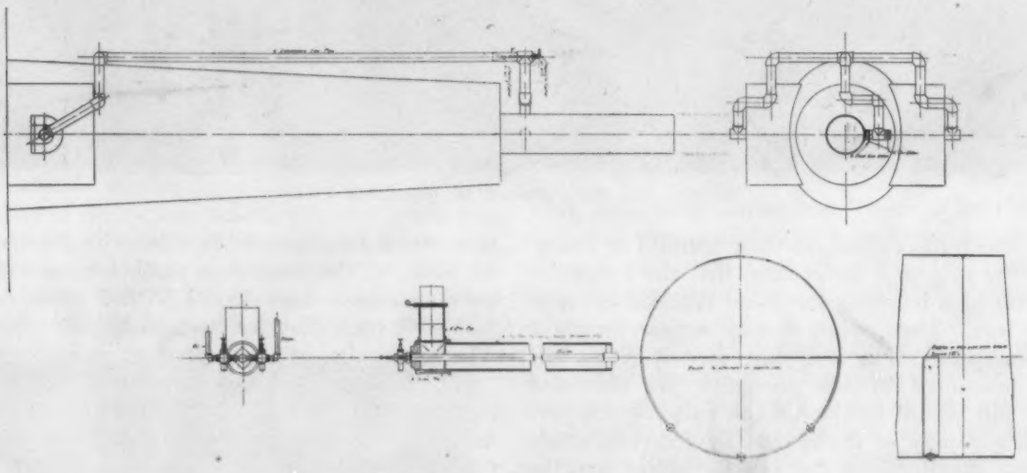


Fig. 104. Oil Burning System for Lime Kiln.

Cement furnaces have been highly conventionalized. They are invariably of the rotary type and the latest practice is divided as to length, some engineers using a kiln approximating 100 ft. and others as high as 270 ft. Two burners are used as a rule in connection with a low pressure air system.

Fig. 105 illustrates such an installation around the furnace head. The furnace head is on a track partly to allow for expansion and partly so it may be readily wheeled out of the way for cleaning, etc. The air is used at about 2 lb. pressure. The oil pipes and heaters are overhead. The burners and shutters are of the type explained in the first part of this article, being swiveled so that they may be pointed to any part of the furnace; two are ordinarily used but are not located symmetrically as shown on the drawing, one being near the center of the furnace and the other on the side that is rotating upwards because the cement clinker lies on this side.

The economies that could be effected with oil fuel for cement burning are not nearly realized. The principal reason is that the product is immensely valuable as compared to the cost of the fuel. About one-

third of a barrel of oil is used in the manufacture of a barrel of cement. The value of the cement at the present market price is $2.40 per barrel as compared to approximately $0.20 for the oil used in making it.

However, great economies can be effected because, as has been determined on the best authority, about 396,260 B.t.u. per barrel is necessary for the manufacture of cement, whereas upwards of 2,000,000 B.t.u. is actually used. This can be bettered by depositing a clinker into a long draft tube through which all of the air for combustion is drawn, abstracting a large portion of the heat for the furnace. This is not done at present, the heat from the clinker coolers being wasted through tall chimneys that operate on the heat from the clinker.

The making of cement consists of two distinct processes: first, the calcining of carbonates to lime which requires theoretically about 2,000,000 B.t.u. per ton or about 230,000 B.t.u. per barrel; second, the process of clinkering, the theoretical heat of which is about 166,000. But clinkering, while not taking much heat, requires a very high temperature, while calcining requires a comparatively low temperature. Therefore, the front of a cement kiln should have very intense combustion, the remainder of the kiln getting along nicely with spent gases and flame tips. As a matter of fact the flame plume will extend the entire length of a hundred foot furnace and part way up the stack, but this is not all true flame; that is to say incandescent carbon in process of combustion but very largely red hot dust.

The great waste of fuel in cement burning is due first to the failure to save the heat lost in the clinker; secondly, the combustion is not kept sufficiently intense at the front of the furnace. The combustion should practically cease in the first 20 ft. of the furnace, the remainder being simply hot gases and dead flame. This can be accomplished with more perfect atomization, pre-heating of the air with clinker, and highly heating the oil. The clinker rings which form in any rotary kiln are broken out by means of long pokers 50 or 60 ft. in length, consisting of heavy 2 in. pipe having a running stream of water which discharges into the furnace when in use. This makes no trouble as the water is converted into steam, disappearing up the smoke stack. The more intense the combustion the nearer will the clinker ring be to the front of the furnace and, therefore, easier to remove, as the ring tends to form at the point of clinkering, although they can and do form at any point where fused clinker exists.

Positive action blowers are used to furnish the air for atomizing air for combustion, coming in by induction partly through the same orifice through which the clinker discharges and partly through the many small orifices always existing in the head of the cement kiln. The following data may be of interest in connection with this industry:

Lime weighs 230 lb. per bbl. or 60 lb. per cu. ft.
Cement weighs 380 lb. per bbl. or 95 lb. per cu. ft. loose, and 115 lb. per cu. ft. packed.
1 barrel equals 3.3 cu. ft.

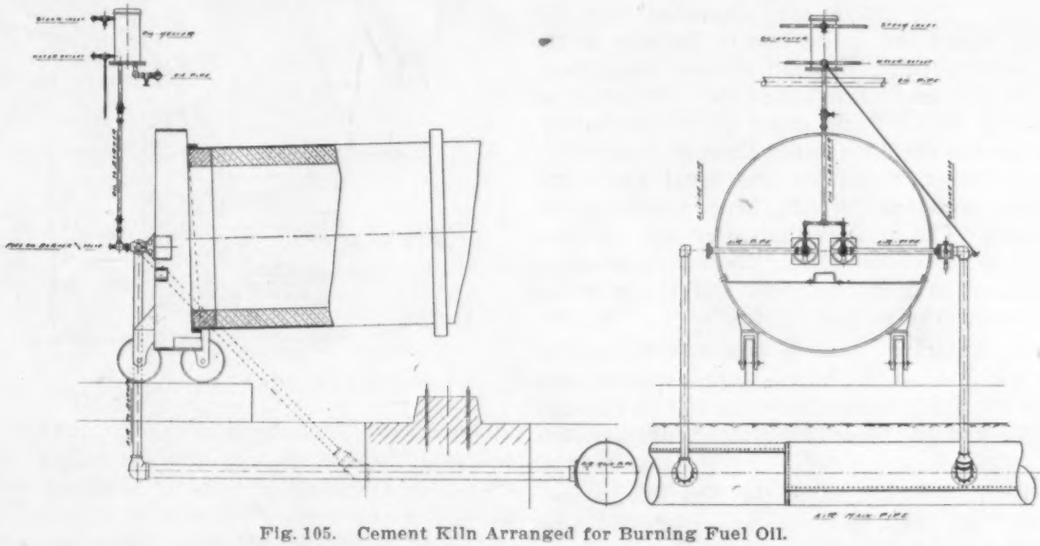


Fig. 105. Cement Kiln Arranged for Burning Fuel Oil.

Volume of cement in a barrel equals 3.2 cubic feet if packed.
4.0 cubic feet if loose.
3.5 cubic feet if shaken.

The barrel itself weighs 22 lb.
One ton of cement equals 5¼ bbl.
One ton of lime equals 8.7 bbl.

Brick.

The making of ordinary red brick, like lime and cement, is a specialty requiring experience of the most intensely practical nature. Ordinary burners are used in connection with oil, but their placing, stacking of the brick, and other details cannot be described here. Fire brick are made in kilns similar to those used for pottery, terra-cotta, vitrified pipe, etc.

There are two kinds of kilns—muffle and open. The muffle kiln surrounds the product with a wall which protects it in part or entirely from the direct action of the fire. The open kiln exposes the ware directly to the fire. It is important in kiln work to have atomization so perfect that the flame itself will not carry over into the ware. Operators fire these kilns anywhere from three days to six weeks; no two operators running alike and no two products running alike, although what is apparently the same grade of ware is turned out.

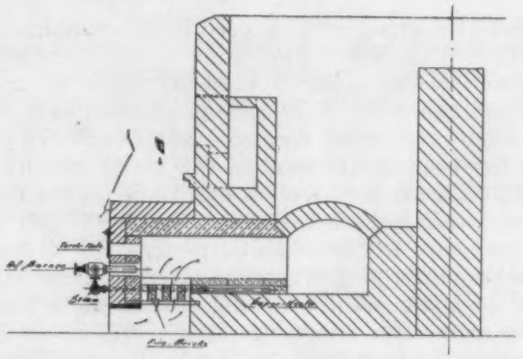
The writer has found one difficulty with all kiln burners and has secured economy and better results in every case where this defect was remedied. It pertains to the arrangement of the burner. Kiln oper-

ators seem to particularly desire to have their burner lying on the ground or near it so that most of the air goes in over the burner and it smokes and deposits carbon continuously. In every case where the writer has raised the entire burner pipe and pointed the burner so that the flame shoots down toward the bottom of the oven in this way compelling all air to go through the flame, thus observing the principles previously laid down in this article, a marked economy has been effected. There is no necessity for operating a smoky burner on a kiln or elsewhere.

In one case a porcelain company was bothered with black and red specks in their ware. After a great deal of trouble and many analyses the writer established the fact that these specks were iron oxide and carbon. A study of conditions developed the fact that the iron oxide was due to the oxidizing of iron present in the clay under a high temperature with excess of air. The carbon was deposited from the burner. He raised the entire line of burners to the top of the oven openings instead of their usual position near the bottom and arranged the brick work so that absolutely no air could enter above the burner. Below the burner the air entered through a carefully constructed checker work, not the usual haphazard pile of bricks with one missing here and there for draft purposes. The product thereafter was satisfactory without specks of any kind. The consumption of oil was reduced over 20 per cent and the kiln did not smoke during any part of its run.

Fig. 106 illustrates such a kiln and it will be noted that the floor of the kiln is supported on piers and that the hot gases enter the chamber both through the wall bags and to the center orifice from between the piers.

Fig. 107 illustrates some of the details of a correctly bricked up oven. It will be noted that this



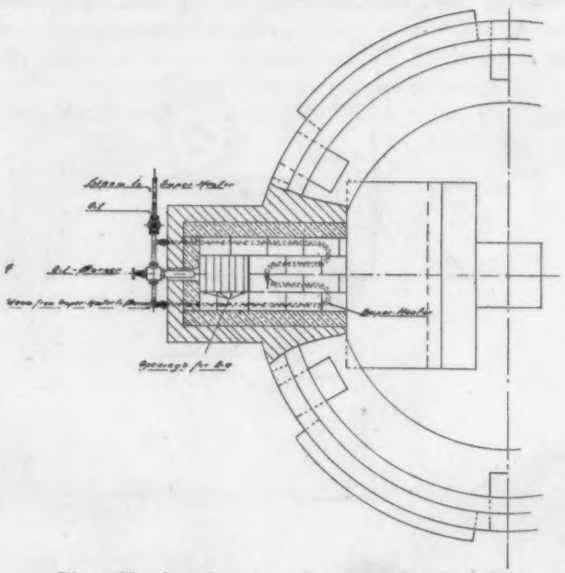


Fig. 107. Details of a Correctly Bricked Oven.

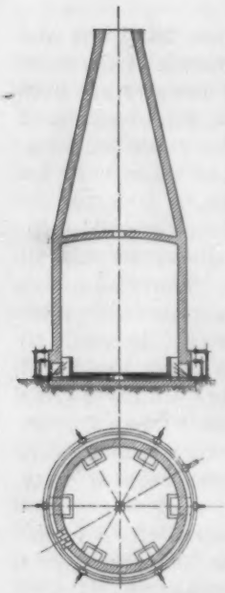


Fig. 106. Porcelain Kiln

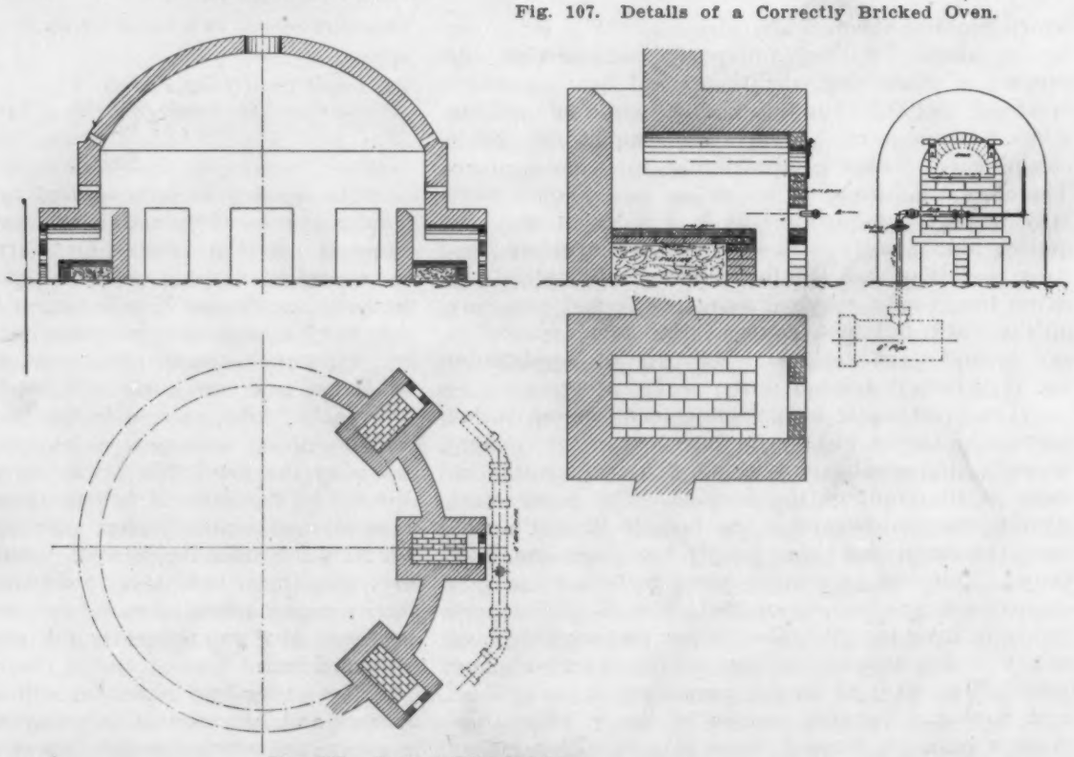


Fig. 108. Correct Kiln Bricking.

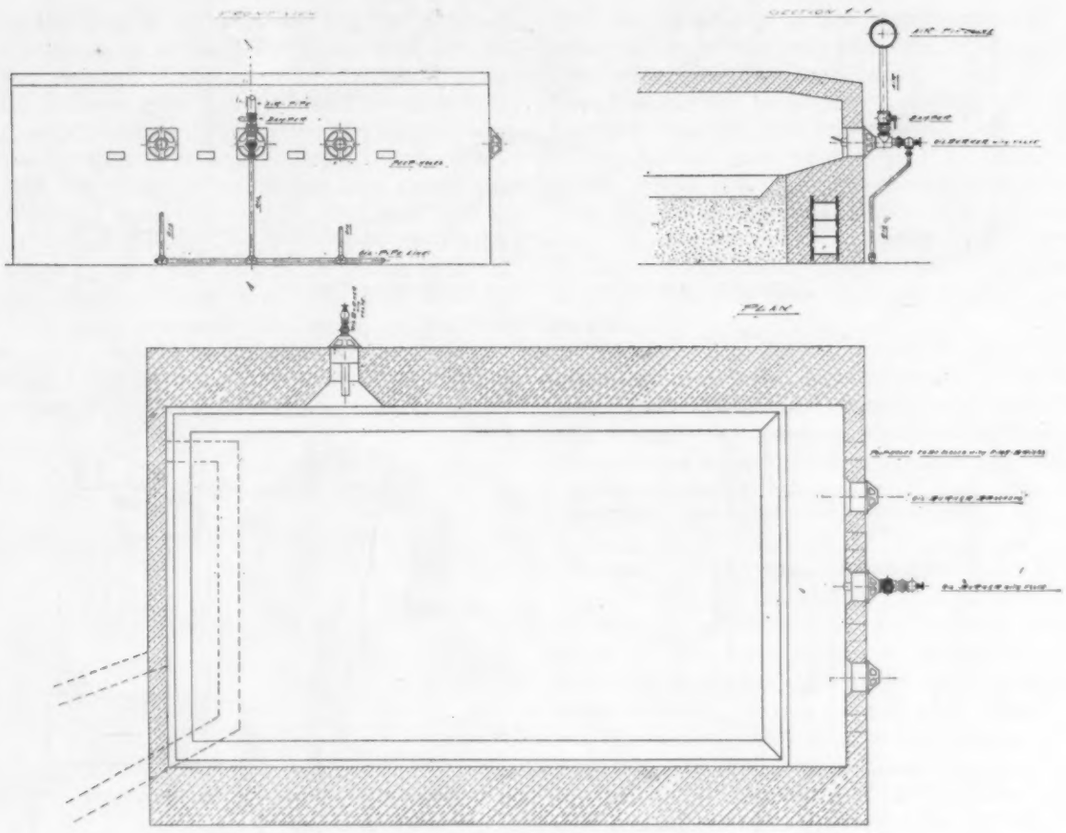


Fig. 109. Reverberatory Furnace for Burning Fuel Oil.

is very different from the haphazard work usually done around a kiln, yet with an oven bricked up in this manner it is perfectly possible to operate a kiln from beginning to end with absolutely no smoke excepting for perhaps ten minutes in the beginning. It will be noted that there is a heating coil imbedded in the brick work. This is intended to super-heat the steam only, and it should be pointed out that a great deal of trouble in kiln work results from the practice of not heating the oil. The importance of heating the oil has been previously emphasized in these articles and it should be stated here that a coil of pipe in the storage reservoir is not sufficient to heat the oil. There should be a special steam heater on every kiln to heat the oil just as it enters the kiln and all pipes for steam and hot oil should be carefully lagged if the best results are obtained. These various points are not unnecessary refinements because they will pay for themselves within a few months of their installation, and in some cases have paid for themselves completely with the first charge of the material.

Fig. 108 illustrates another arrangement for the oven which is probably just as good since the same principles are observed in connection with this. It might be noted that vitrified or terra cotta pipe may be used as air mains.

Smelting.

The smelting of copper, iron and other metals with oil is a metallurgical specialty in each case, but any of them will use the reverberatory or regenerative reverberatory for the purpose, oil not having as yet been applied successfully to direct cupolas or blast furnaces although there are several tilting furnaces on the market for the use of oil in melting iron, brass, lead, copper, etc.

The reverberatory furnace in its elementary form is shown in Fig. 109. It is simply a fire brick oven of very careful mechanical construction fired from various points at the ends and sides, the molten metal lying in a bath in the center; the roof being a dome the thrust of which is taken up with rods and back stays. The arrangement of the burners must be in accordance with experience in the particular metal or even in the particular ore to be treated. The simple reverberatory furnace is very wasteful because the temperature of the molten metal is almost the temperature of combustion, the difference being the only economy which can be realized and the temperature of the stack gases is equal to or actually in excess of the temperature of the molten metal. This has led to the construction of the regenerative furnace; that is to say, a furnace from which these intensely heated products of composition pass through a brick checker work to which it gives up a part of its heat. In the meantime the incoming draft is passing through a similar checker work which has been previously heated in the same manner and the draft enters the furnace at a very high temperature increasing the temperature of combustion and effecting a very great economy. After a certain length of time this cycle is reversed, the waste gases passing out through the cool chamber and the draft coming in through the renewal heated chamber.

Fig. 110 shows a further refinement of regenerative reverberatory practice. The air before going to the reverberatory furnace is partially heated by oil because the oil thus used can act more efficiently on

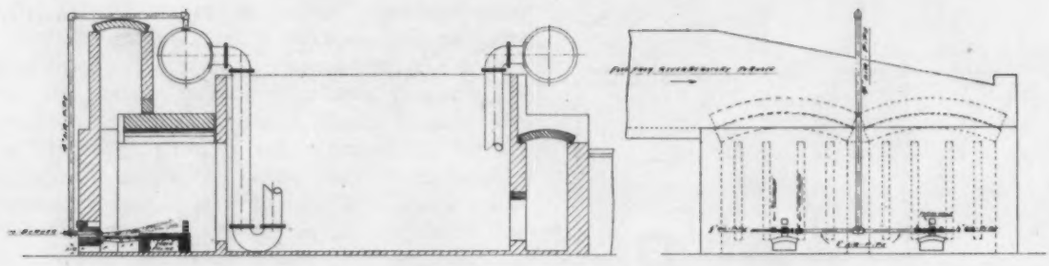


Fig. 110. Air Heater Arranged for Burning Fuel Oil.

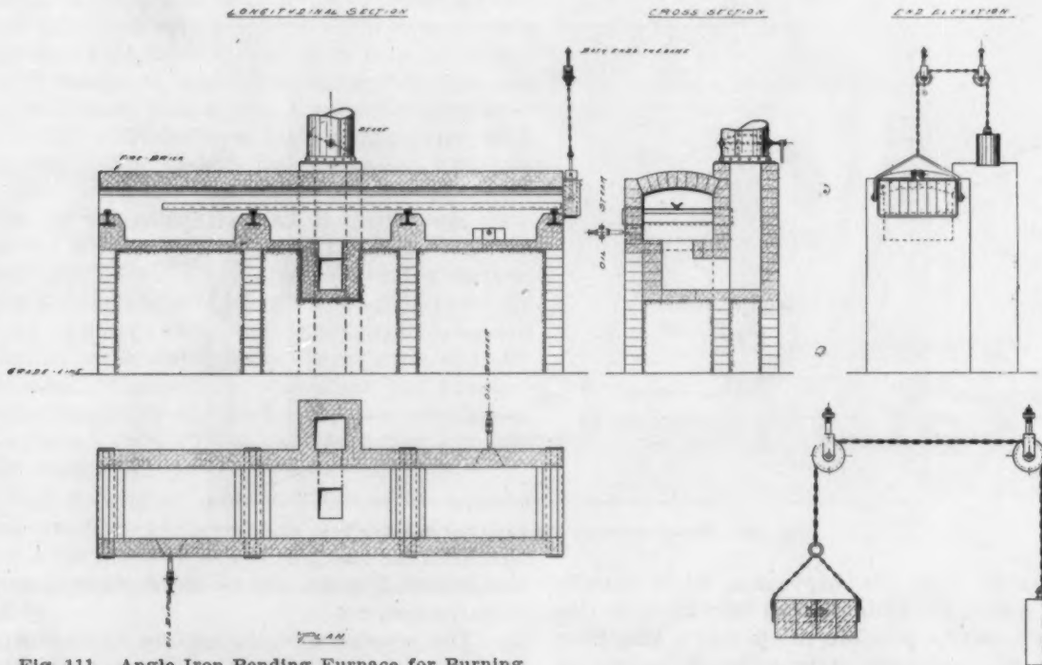


Fig. 111. Angle Iron Bending Furnace for Burning Fuel Oil.

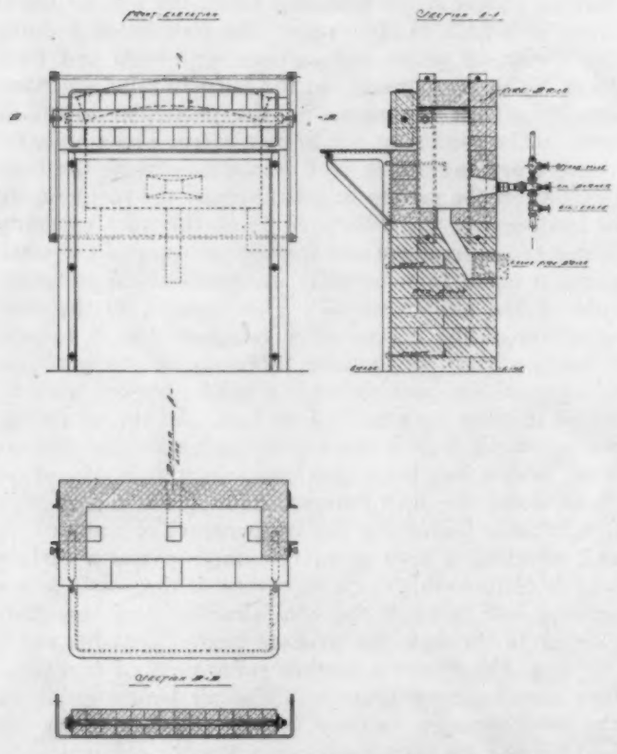


Fig. 112. Bolt Forge for Burning Fuel Oil.

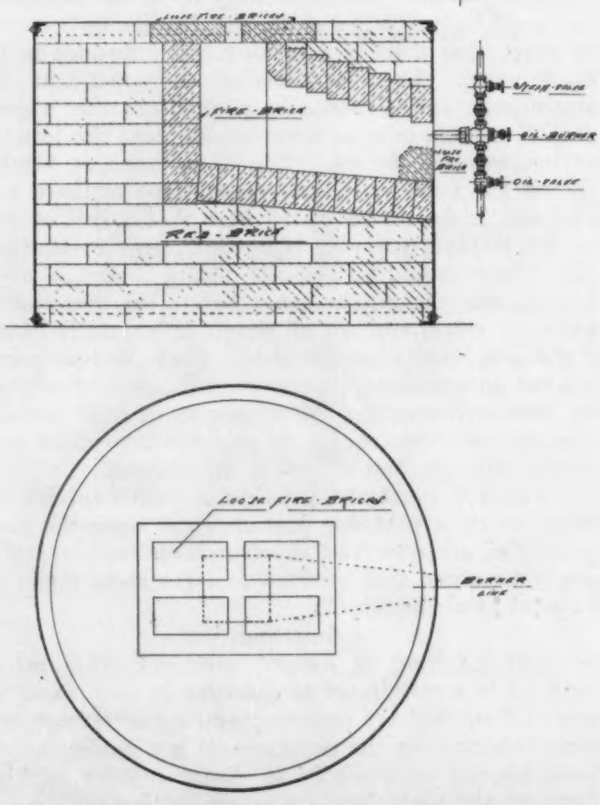


Fig. 113. Blacksmith Forge for Burning Fuel Oil.

account of the greater temperature range. Some reverberatory furnaces have all the burners at one end and put the material in at the other end, having thus a gradually increasing temperature and comparatively cool stack which results in a certain amount of economy, but this system is difficult to work practically.

Fig. 111 shows the arrangement of a furnace for heating structural iron, ship frames, etc., with fuel oil.

Fig 112 is an ordinary forge particularly adapted for bolt heating, and Fig. 113 is an ordinary blacksmith forge. Both of these have been used in actual practice with great success. The detail of the brick doors and covers should be noted as they are particularly difficult to construct on account of the brittleness of ordinary fire brick.

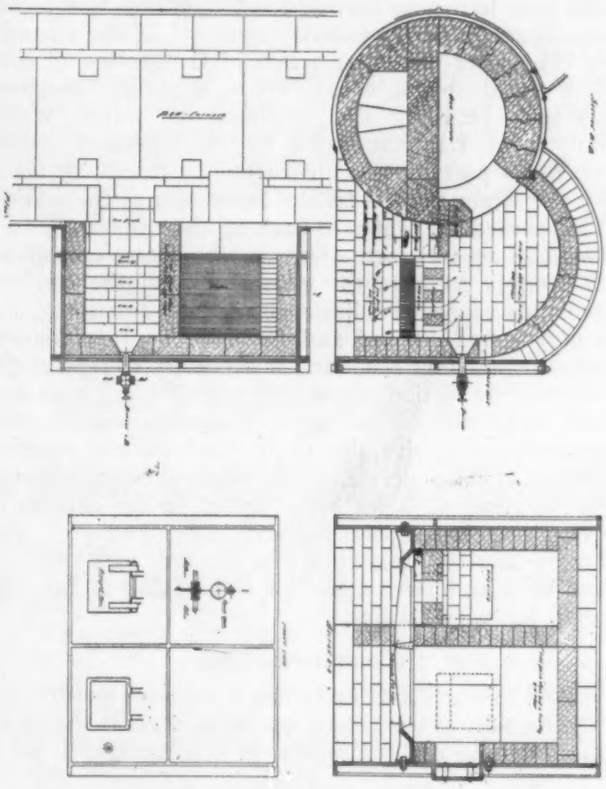


Fig. 114. Bar Furnace for Burning Coal and Oil.

Fig. 114 illustrates a bar furnace intended to burn either coal or oil or both together. This fuel condition being one that is often met in all classes of work. There are furnaces in actual operation today which burn three fuels, any two at once or any one alone.

Fire Brick.

In addressing this information to the practical man it is proper at this point to say something about fire brick. The most refractory material there is in the commercial world is pure lime, and a pure lime brick is practically invulnerable, but as it has no strength whatever a compromise known as the fire brick has been developed. A fire brick has two determining qualities, viz: strength and refractoriness. It is not possible to have an extremely strong brick that is also refractory, nor to have an extremely refractory brick that is very strong, and an engineer must make up his mind which he needs for a particular situation.

The chemistry of fire brick is entirely too complicated to go into here but certain elements may be touched upon. The best known foreign fire brick are found to consist principally of silica with one and a half per cent of lime for a binder and it will stand in the hottest part of a refractory furnace for four or five weeks at a temperature of 4000 to 4500 degrees. This implies simply when exposed to the action of the fire. If exposed to the action of molten ores, metals or slags, the abrasion then becomes chemical in character and must be called to the attention of the metallurgist.

Quoting from "Terra Cotta Topics": "Magnesite when calcined loses half its weight in carbonic acid gas. The dead burned material may then be ground and mixed with various binders, such as clay, anhydrous gas tar, magnesium acetate, magnesium chloride, carbonate of lime, oxide of iron, soda and either the silicate or oxide of iron. Bauxite, whose composition in alumina, 60 per cent; silica, 23 per cent; water, 15 per cent; and oxide of iron, is hard to be found constant and is seldom used, although very refractory."

The most infusible fire brick would consist exclusively of silica and alumina. Our good practical friend must not think that this is silicon and aluminum because it is not. It is a form of their oxides. It is not possible to find a material of this nature but the best fire clays are very high in these two constituents and the brick made from them are of excellent quality. The coarseness of the particles have much to do with the refractoriness of a fire brick. The more porous fire brick is the more infusible it is.

Another important increment of the strength and refractoriness of the fire brick is the length of time it is seasoned before being burned. Fire brick should be laid in a minimum of mortar of their own composition. It should be remembered that fire clay does not cement except in the slightest degree, the intention with fire brick always being that they will fuse or glaze into a homogeneous surface, thereby obtaining such bond as they need, but the stability of fire brick structure should depend upon careful joints and proper construction rather than mortar. Ordinary fire brick such as can be procured at about $30 per thousand f.o.b. San Francisco will do for all ordinary work, but where they must receive the direct flame, as in a forge, or be subject to tremendous radiation and flame as in a reverberatory furnace, there should be two courses of brick, one to withstand the flame and support themselves and another to assist in the structural support.

Those who wish to be a little more technical in their consideration of fire brick are referred to the method of Dr. Carl Bischof, a German chemist. He divides the clay into two parts: the silica and the alumina constituting the refractory part and the impurities the fluxing part. From these he derives a formula as follows, the summation of which is the index of refractoriness. Letting R O stand for the total impurities the formula will be as follows:

$$\frac{Al_2O_3}{RO} + \frac{SiO_2}{Al_2O_3} = \text{Refractoriness.}$$

It is very easy to understand the acid and basic

action of brick in metallurgy. It is only necessary to remember that when metals or ores are molten they are just the same as laboratory re-agents and act as acids, bases, salts, etc., and will dissolve substances, crystallize and precipitate, and do all of the things that liquid re-agents do. In this manner certain molten materials will dissolve certain brick and have no effect upon others. Some of these materials for which brick must be carefully chosen are molten copper, iron, sulphur, porcelain, glass and lead. It has been stated that the user who needs an acid brick need not buy a basic brick but one who needs a basic brick must not buy an acid brick.

In connection with brick and its physical properties the reader is referred to articles written on the manufacture of oil gas by the writer for the Journal of Electricity, Power and Gas, of February 18, 1911. The manufacture of gas from petroleum is too wide a subject to take up in connection with this article, but interested readers are referred to the aforesaid article.

PRESENT STATUS OF LOS ANGELES AQUEDUCT.

A resume of the Los Angeles aqueduct construction up to December 1, 1911, and a prognosis of its finish are contained in a letter just sent by Gen. Adna R. Chaffee, executive head for the Board of Public Works and William Mulholland, chief engineer of the big project, to Kountze Bros. and A. B. Leach & Co., of New York, who head the syndicate that purchased all the aqueduct bonds to date.

The statement was prepared in answer to the following queries put by the syndicate and which evidently resulted from the alarming statements made by the Harriman party in the recent municipal campaign.

(1) Accidents to the aqueduct; cause, extent of injury, and probable and actual cost of repairs.

(2) Work done to date; cost, quality of construction and materials, amount of work remaining to be done, and estimate of time and cost for completing the same.

(3) Rights of city in respect to control and use of water to be supplied by the aqueduct, and concerning any controversies with the Federal authorities over water rights.

Accidents.

As might reasonably have been anticipated on construction stretching over a distance of 213 miles, there have been many accidents, though most of them have been comparatively unimportant. In only two instances have substantial failures of work occurred, and these were due to extremely difficult natural conditions, and not to defects in plan, workmanship or materials. In July, 1911, while constructing the concrete regulating gate in the aqueduct, just below the point of diversion from Owens River, the river reached a height unknown for more than thirty years before. By reason of the uncompleted condition of the work and the greenness of the cement just placed, the flood waters broke under and around the gate and ran down the canal for about five miles, where they were turned out and flowed back into the river. As soon as the flood subsided the gate was replaced, and additional construction in the way of sheet steel piling and concrete shut-off walls, suggested by the experience from the flood, was put in. The total amount of damage to the work hardly exceeded $1000; the additional construction mentioned cost about $3400.

The other failure of work referred to occurred at the point where the aqueduct crosses what is known as "Tehachapi Wash, about three miles north of the town of Mojave. A section of conduit about 1200 feet in length had been built across a delta composed of sand, gravel and boulders, which had been carried by flood waters from Tehachapi Canyon and deposited on the plain below. As afterwards appeared this material, though laid down by natural hydraulic process, had been left in an uncompacted condition, due to the rapid passage of the carrying agency. In the summer of 1910, after the construction of the section of conduit mentioned, a cloudburst occurred in Tehachapi Canyon, resulting in a flood of water which ran down over the delta to the aqueduct work, where its passage was obstructed by the dump made by the steam shovels on the lower side of the trench. This caused the water to back up over the work to a depth of several feet, where it stood long enough to thoroughly saturate the ground around the conduit, and thus caused a subsidence of the formation. The concrete was cracked and fractured by this disturbance to an extent rendering it necessary to replace the work in the section mentioned, and this was done at a cost of $27,000. The cost of this reconstruction was somewhat excessive, due to the hardness and superior quality of the concrete, which required heavy blasting for its removal, holes being drilled in the corners of every two foot square and shot with dynamite. The broken concrete was then run through rock crushers and used as broken stone for the making of the concrete for the new line.

Completed Work.

As to work done and to be done, cost, quality, etc. The amount of work done and to be done is shown by the following table, compiled as of December 1, 1911:

AQUEDUCT MILEAGE SCHEDULE.

Class—	Total mileage.	Completed 12-1-'11	Percentage of accomplished.
Tunnel excavation	42.88	42.21	98.5
Tunnel lining	42.88	30.40	71.0
Colored conduit excavation	97.56	80.46	88.5
Covering conduit lining	97.56	78.14	80.3
Open conduit excavation	39.30	19.85	50.5
Open conduit lining	39.30	18.80	47.9
Unlined canal	21.30	20.92	98.3
Siphon excavation and piers	12.03	4.38	36.5
Siphon steel pipe	9.38	1.05	11.2
Siphon construction pipe	2.65	1.72	65.0
Flume excavation and piers	.17	.17	100.0
Flume waterway	.17	.17	100.0
Total excavation	213.24	167.99	78.9
Total lining	191.94	130.28	68.0

Cost of Work.

The cost of the work done, estimated total cost of each feature of the project, and the percentage in value of work accomplished, are shown by the following table, compiled as of December 1st, 1911:

EXPENDITURES AND PERCENTAGES.

Class—	Cost to date.	Approximate total cost.	Percentage of class accomplished in value.
Tunnels	$ 5,418,009	$ 5,915,000	91.5
Conduit and auxiliaries	5,123,122	7,000,000	73.2
Canal	190,142	195,000	97.5
Siphons	478,706	1,965,000	24.4
Flumes	38,588	40,000	100.0
Reservoirs	318,467	510,000	62.3
Lands	1,696,590	1,725,000	98.2
All auxiliary expense, including engineering, administration, buildings, cement mills, pipe lines, roads, power systems, equipment, etc.	6,453,433	6,650,000	97.2
Totals	$19,717,057	$24,000,000	82.3

The percentage of expenditure on the work, based on the total authorized appropriations for the same, including premiums received on bonds, but excluding moneys received or to be received from salvage, is shown by the following table, compiled as of December 1st, 1911:

Bond issue, 1905	$ 1,500,000.00
Premium and accrued interest on 1905 bonds	17,246.33
Bond issue, 1907	23,000,000.00
Premium on 1907 bonds	68,850.00
Total	$24,586,096.33
Total amount expended on work	$19,717,057.00
Percentage of authorized appropriations expended	80.2

It should be noted here that the above estimate of $24,000,000 for the completion of the project includes 515,000 lineal feet of conduit cover, costing approximately $1,000,000, and that this feature of the work was not included in the original estimate of $24,500,000.

The above statement of expenditures and estimates of cost is subject to minor corrections and changes to be made in the semi-annual estimate now in preparation.

It should be stated, as bearing upon the question of the ultimate net cost of the completed aqueduct that the salvaging of construction equipment, including cement, mill, electric power plants, steam shovels, livestock, etc., will probably yield more than $1,000,000, but, owing to the fact that this equipment to a large extent must be kept in commission until the whole work is completed, the benefits from such salvaging must be postponed until that time.

It is now estimated and expected that the construction of the aqueduct will be completed in the early part of 1913.

The materials used in the construction of the aqueduct are of standard quality. The cement manufactured or purchased by the city for the work has conformed to the requirements of the American Society of Civil Engineers and the United States Army and Navy. Reports from the government testing laboratories at Pittsburgh upon the city's tufa cements show a strength, at the age of ninety days, of 100 pounds to the square inch greater than Atlas Portland cement, which, for the purposes of such tests, was apparently taken as a standard Eastern cement.

Eleven miles of the aqueduct was let to contract, and this has been finished; the rest of the work is being done by the city by force account.

Concerning the quality of the work done, while it is not pretended or claimed that in the 140 miles of concrete lining no cracks or pieces of poor concrete can be found, still, the extent of such defects is within a reasonable percentage, and the work as a whole is good, durable and satisfactory.

Sections of the aqueduct, as soon as completed, are thoroughly tested by erecting dams therein at intervals of three or four miles and filling with water, which is allowed to stand indefinitely. Frequent observations are made to determine seepage losses or defects in the work, and complete records are kept of these readings. In this way over forty miles of the aqueduct have been tested out, and found entirely satisfactory.

Water Rights.

The water rights of the city of Los Angeles in the Owens River Valley were acquired by purchase from private individuals and corporations, and by appropriation. The rights so purchased are not affected by any reservation or limitation, in deed or law, in favor of the former owners. The city is authorized by its charter and the general law of this State to provide a water supply sufficient for its present and future needs; it is also authorized to provide for the temporary sale of its excess supply, for irrigation, domestic uses and other purposes outside of the city. The question has been raised, particularly by parties opposed to the aqueduct project, as to whether the city, after having commenced to furnish water for use outside of the city, can withdraw the service. While the general opinion is, that the city could do so whenever the water is needed for use within its limits, the doubt expressed on this point, only means that the city, in disposing of its excess water, will be particularly careful, in any instruments drawn, or ordinances or resolutions passed, to safeguard its rights against any possible loss. It also means that the disposal of the excess supply will, in all probability, be limited largely to unincorporated territory, which, by reason of relative location, seems destined sooner or later to be within the city.

The city of Los Angeles has no controversies with the United States authorities in reference to any water rights. It has several applications pending for rights of way for various purposes, but the question of water rights is not involved therein.

COMPUTATION OF HORSE POWER FOR RECIPROCATING ENGINES.

BY ROBERT SIBLEY.

It frequently devolves upon the practicing engineer to compute the approximate horsepower of a reciprocating engine when no indicator cards are at hand. It is possible to arrive at the horsepower quite approximately by measuring certain of the engine constants. The problem naturally divides itself into two cases. The first case is less accurate than the second. In the first instance we must have given the boiler pressure, point of cut-off, length of stroke and number of revolutions per minute, at which the crank operates. In the second case we must have given in addition to the data mentioned above the point of compression and the clearance in the engine cylinder.

Case 1. Let us now consider the first case. We have previously found that the horsepower of an engine is computed by the formula

$$H.P. = \frac{P\,L\,A\,N}{33000}$$

in which P is the mean effective pressure in pounds per sq. in. pressing against the piston head, L is the length of the stroke in ft., A is the net area of the piston head in sq. inches, N is the number of strokes per minute.

The particular problem then that we have in hand is to devise some method whereby we can compute without the means of an indicator card, the mean effective pressure or in other words the average pressure in pounds per sq. in. coming upon the piston head. In the expansion of steam after cut-off has taken place, the work that is accomplished during the remainder of the stroke is done by calling upon the reservoir of energy stored in the steam itself. Such an expansion in which no heat is given or no heat is taken away is called adiabatic expansion. In the case of a steam engine, however, where the steam enters a comparatively cool steel cylinder a certain amount of condensation takes place during the early portion of the stroke and evaporation during the latter portion of the stroke. It is found that the expansion in the steam cylinder under these conditions

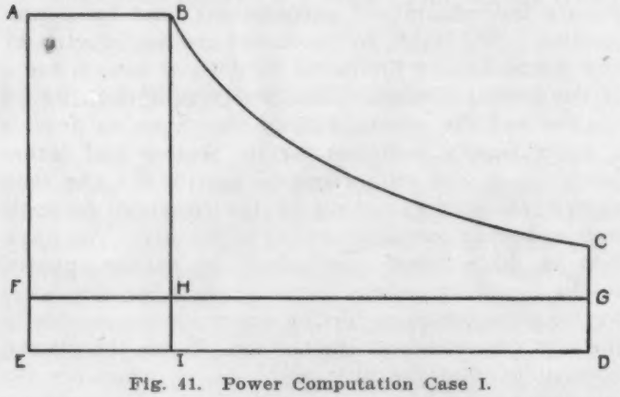


Fig. 41. Power Computation Case I.

corresponds more nearly to isothermal than to adiabatic expansion; that is, the temperature throughout the entire expansion practically remains constant. Assuming then that the expansion is isothermal we have for the entire work during one stroke of the engine cylinder the following:

$$\text{Work per stroke} = p_1 v_1 + p_1 v_1 \log_e \frac{v_2}{v_1}$$

in which p_1 is the initial pressure in pounds per sq. ft., v_1 is the initial volume of steam in cu. ft. and v_2 is the final volume of steam in cu. ft.

This easily can be seen by looking for a moment at Fig. 41 in which the line E D represents volumes to scale and the line E A represents pressures to scale. Let us lay off the boiler pressure and let the line E A represent to scale this pressure. Let us now assume that the piston head moves from A E to B. I. It is seen, then, that this expansion takes place under constant pressure and we have formerly seen that the work done by gas in expanding under constant pressure is computed by multiplying the pressure and the volume or in this case it is $p_1 v_1$. Again as the piston head moves from B I to K D the gas expands as we have seen, isothermally and consequently the pressure falls off along the line B C. We have previously seen that work in isothermal expansion is found by multiplying the pressure and the volume into the natural logarithm of the final volume divided by the initial volume, in other words, $\text{Work} = p_1 v_1 \log_e \frac{v_2}{v_1}$

Hence the total work performed in the entire stroke is the sum of these two separate quantities and we are at once enabled to write the equation hinted at above. Or

$$\text{Work per stroke} = p_1 v_1 + p_1 v_1 \log_e \frac{v_2}{v_1}$$

Since there are N of these strokes which take place per minute the total number of foot pounds of work accomplished per minute is

$$\text{FT. LB. of work per min.} = N\,p_1 v_1 \left(1 + \log_e \frac{v_2}{v_1}\right)$$

Let us call the number of times the volume increases during expansion the ratio of expansion r and if l is the distance from the beginning of the stroke to the point at which cut-off takes place, v_1 is equal to l a, in which a is the piston area in sq. ft. and v_2 being the final volume after the stroke L has taken place becomes equal to L a, therefore $r = \frac{v_2}{v_1} = \frac{L\,a}{l\,a} = \frac{L}{l}$. Since now p_1 times a is equal to the total initial pressure in which p_1 is the initial pressure in pounds per sq. ft. and a the area in sq. ft. We also have, since P_1 is the initial pressure in pounds per sq. in. and A

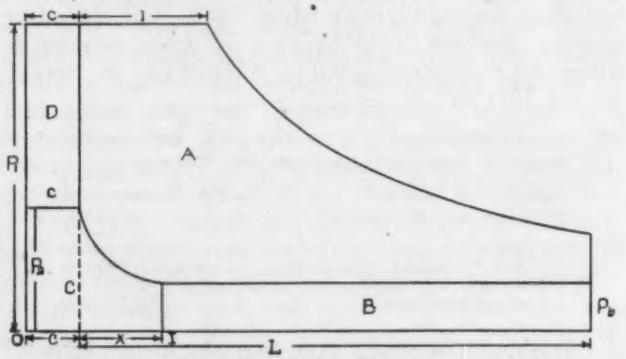


Fig. 42. Power Computation Clearance and Compression Considered.

the area in sq. inches, p_1 v_1 equal P_1 A i, hence we have that the horsepower in an engine cylinder can be computed by the formula.

$$H.P. = \frac{[P_1 l\,(1 + \log_e r) - L\,P_b]\,A\,N}{33000}$$

since there are 33,000 ft. lb. per min. work in one horsepower. We have that the total horsepower is computed by the formula, since $r = \frac{L}{l}$,

$$H.P. = \left[P_1 \frac{(1 + \log_e r)}{r} - P_b\right] \frac{L\,A\,N}{33000}$$

In other words if we let the mean effective pressure $P = P_1 \frac{1 + \log_e r}{r} - P_b$, we come back to our original equation

$$H.P. = \frac{P\,L\,A\,N}{33000}$$

As an illustration let us take the following example: A simple steam engine is found to have the following constants: Boiler pressure 80 lb. gauge, point of cut-off is 6 in. from beginning of stroke, complete stroke 24 in., diameter of cylinder 18 in., revolutions per min. 120, exhaust back pressure 1.3 lb. gauge. What is the horsepower?

We have found above that the horsepower is expressed by the formula

$$H.P. = \frac{PLAN}{33000}$$

in which $P = [\frac{P_1\ (1 + \log_e r)}{r} - P_b]$

By reference to our data we find that

$P_1 = 80 + 14.7 = 94.7 \qquad P_b = 1.3 + 14.7 = 16$

$r = \frac{24}{6} = 4 \therefore \log_e r = 2.306 \log_{10} 4 = 1.3863$

$L = \frac{24}{2} = 2$ ft., $A = \frac{\pi d^2}{4} = .7854 \times 18^2 = 254.5$, $N = 2 \times 120 = 240$

Hence substituting, we have

$$P = \frac{P_1\ (1 + \log_e r)}{r} - P_b$$

$$= \frac{94.7\ (1 + 1.3863)}{4} - 16 = 56.55 - 16 = 40.55$$

$$\therefore H.P. = \frac{PLAN}{33000} = \frac{40.55 \times 2 \times 254.5 \times 240}{33000} = 150. \quad \text{Ans.}$$

Case 2. Referring now to Fig. 42 we are enabled to compute still more exactly the approximate h.p. of an engine by taking into account the clearance and also the compression. By referring to this figure it is seen that the net area which goes toward work is that indicated by A in the diagram. In order to compute this quantity A it is necessary for us first to compute E, the sum of the areas A, B, C, D and subtract from this sum the areas B. C and D. Looking now at Fig. 42 we see that the area of A, B, C, D is evidently

$$E = P_1\ (1 + c) + P_1\ (1 + c)\ \log_e \frac{L + c}{1 + c}$$

$$= P_1\ (1 + c)\ [1 + \log_e \frac{L + c}{1 + c}] \quad . \quad . \quad . \quad . \quad (1)$$

Let us assume the distance O I to be equal to $x + c$ in which c is the clearance and x the point of the stroke where compression takes place. Hence if we call P_b the back pressure on the cylinder when exhaust has taken place we have the area

$$B = P_b\ (L - x) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

We also similarly find that the area C is equal to $P_2 c + P_2 c \log_e \frac{x + c}{c}$, in which P_2 is the pressure after compression has been completed in the cylinder. $P_2 c + P_2 c (\log_e \frac{x + c}{c}) = P_2 c\ (1 + \log_e \frac{x + c}{c})$ and since this is a case of isothermal expansion we have that $P_2 c = P_b\ (x + c)$. Hence substituting we have that the area of

$$C = P_b\ (x + c)\ (1 + \log_e \frac{x + c}{c}) \quad . \quad . \quad . \quad (3)$$

The area of D is $c\ (P_1 - P_2)$ or $P_1 c - P_2 c$. But since $P_2 c$ is equal to $P_2\ (x + c)$ we have that the area of

$$D = P_1 c - P_b\ (x + c) \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

If now taking the engine constants, we substitute carefully in these different formulas for A, B, C, D, we can at once compute their values and arrive at a very approximate computation for the work done at each stroke. In other words we can arrive again at a very approximate value for the mean effective pressure upon the piston head during each stroke.

To be clear in our method of procedure, let us go more into details. In order to compute the horsepower of an engine by this more exact method, we must first measure up the constants necessary in the solution of the four equations derived above and then having computed E, B, C, D as shown in the four equations, we have, looking at Fig. 42, the area

$$A = E - (B + C + D)$$

This quantity A when thus properly computed is equivalent to the "P L" in the general equation.

$$H.P. = \frac{PLAN}{33000}$$

As an illustration of this second case involving the clearance in the engine cylinder and the steam left in the cylinder after compression begins, let us assume that the engine has the same characteristics as given in the first example, but in addition that the clearance is 1/10 of the stroke and that the point of compression is at 20 in. from the beginning of the return stroke.

From equations 1, 2, 3 and 4 above, we have

$$E = P_1\ (1 + c)\ [1 + \log_e \frac{L + c}{1 + c}] \quad . \quad . \quad . \quad (1)$$

$$= 94.7\ (\frac{6 + 2.4}{12})\ [1 + \log_e \frac{24 + 2.4}{6 + 2.4}]$$

$$= 66.3\ [1 + 1.145] = 142.5.$$

$$B = P_b\ (L - x) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$= \frac{16\ (24 - 4)}{12} = 26.65$$

$$C = P_b\ (x + c)\ [1 + \log_e \frac{x + c}{c}] \quad . \quad . \quad . \quad (3)$$

$$= \frac{16\ (4 + 2.4)}{12}\ [1 + \log_e \frac{4 + 2.4}{2.4}]$$

$$= \frac{16 \times 6.4}{12}\ [1 + .9810] = 16.90$$

$$D = P_1 c - P_b\ (x + c) \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$= \frac{94.7 \times 2.4 - 16 \times\ (4 + 2.4)}{12}$$

$$= \frac{227.4 - 102.4 = 10.41}{12}$$

$$\therefore B + C + D = 26.65 + 16.90 + 10.41 = 53.96$$

$$\therefore A = 142.50 - 53.96 = 88.54$$

But—

$$H.P. = \frac{PLAN}{33000}$$

Hence

$$H.P. = \frac{88.54 \times AN}{33000}$$

$$= \frac{88.54 \times .7854 \times 18^2 \times 2 \times 120 = 175.8}{33000}$$

THERMOTWISTERS.

1. A simple double-acting engine receives steam at 75 lb. gauge and operates condensing with 24-in. vacuum. The stroke is 48 in., the point of cut-off at 1-5th stroke, the revolutions per minute of the crank, 95; the diameter of the cylinder bore 30 in. What is its horsepower?

2. The above engine has a clearance of 1-9th stroke and the point of compression takes place 5-6th stroke on the return. With this added information compute more accurately the horsepower of the above installation.

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An Electrical Engineer's Prayer

The year returns and brings us the petty rounds of irritating concerns and duties. Help us, as we look into the bridal veil of mist shielding the blushing waterfalls so soon to be united forever with the stir and whir of man's industrial mechanisms, to feel that there is in Nature a silent yet resourceful supply of energy with which to overcome the cares and worries of our daily life.

When we follow with our eyes the noiseless transmission lines reflected in the stilly moon-lit night, may we ponder in our hearts how best we may put forth the same quiet yet forceful influence they exert for good among the affairs of men in the city a hundred miles away.

Let cheerfulness abound with industry, and as we watch the synchronous converter spinning out an even uniform current though propelled by positive and negative forces, may it imprint its lesson of harmony and industry deeply upon our thoughts and be of material assistance in our maintaining thorough synchronism with the affairs and inner life of our fellow men.

Give us to go about our business with industry and as often as we gaze into the recording dial of the watthour meter, may it, like the hour-glass of old, remind us of the passing of time with its opportunities, and as it measures off the energies put forth by the distant water-powers, may it remind us of the unseen watthour meter ever recording our energies and spur us on to higher and nobler acts.

May the low sob of the pulsating transformer entune our higher nature, and as the transformer secondary breathes and throbs with energies put into it by the pulsating primary, so may we of the sterner sex remember that largely the very life and heartbeats of family ties are nourished and strengthened by our energies; and in this conviction may we endeavor at all times to play the man.

And finally, each night may we come to our resting place weary and content, bearing in mind a picture of a day well spent, a day of passions governed with the same delicate mechanisms which control the energies of the power house of sufficient strength to turn the wheels of a city.

And now grant us—grant us now that we may close—may close our eyes in sleep. Amen.

Activities Ahead

Nineteen hundred and twelve ushers in an interesting panorama in the West. Montana, convinced of the wonderful lessening of mining costs by means of electric power operation, enters the new year with the brightest prospects ever seen before for hydroelectric operations in the great Treasure State.

Idaho, which has made such wonderful strides in scientific reclamation projects, enters the new year with even brighter prospects ahead. Development of cheap water power brings into the realm of possible reclamation millions of acres of lands, arid in nature, but soon to be an unlooked for pleasant asset to her natural wealth.

Washington, beset with numerous great decisions on water rights and railroad commissions, seems now to have passed the day of uneasiness, and enters a new

year with a better understanding of all parties concerned.

Oregon, with her ever increasing possibilities for hydro-electric development, is in a position to command the respect of the world for her promising agricultural possibilities and reclamation of vast acreages hitherto thought impossible of reclamation.

Nevada, hitherto hindered in its mining operations by inadequate supply of power, seems now to have in sight the early development of hydro-electric enterprises sufficient in their scope to rejuvenate this long lost empire.

Arizona, justly proud of its recent admission into the Union, enters the new year with electric power to operate her mining industry. Thousands of acres of land with waters already properly applied, and thousands upon thousands still waiting to invite the industrious homeseeker of the future, keep the eyes of her people steadfastly to the future.

California, with prospects ahead of the greatest international exposition of history, fairly vibrates through and through with her possibilities.

The entire Coast with but a year before the completion of the greatest engineering feat of history, inwardly pulsates with expectancy. With the commerce of the world so soon to pass its shores a brighter outlook never faced a fairer growing young empire.

The New Year For Electric Traction

If the New Year shall accomplish seats for our kicking strap-hanging friends, commuting from San Pedro to Los Angeles, and earn more revenue for the Pacific Electric Railroad—

If the New Year shall bring peace to the commuters from the suburbs of Seattle and a happy smile of prosperity from the interurban owners of the system—

If the New Year shall see the Inland Empire Railroad hauling into Spokane bigger potatoes and rosier apples—

If the New Year shall give to Portland an electrified railroad system for all trains entering that metropolis—

If the New Year shall make the fine-seated cars of the Southern Pacific system of the bay cities as easy and comfortable as the Key Route system, and the tossy stuffy boats of the Key Route as comfortable and commodious as the Southern Pacific's boats—

We say, if the New Year shall bring about all these events, then God bless you; come again, and return to us for "mony a day" ahead.

Power Plant Education

We have in the West an army of young men, imaginative by nature and strongly adventurous in their make-up. Many of these young men are casting their fortunes in the power industry in our Western hydro-electric power plants.

Although ambitious in the highest degree, unless surrounded by the proper environment, much of the energies which would naturally be devoted to digging out the laws governing the perfect operation of the power plant, are diverted into other channels.

A thousand times during the busy day even the most industrious operator has a minute here and a minute there which he could be profitably devoting to improving his general knowledge in affairs electrical. We are all of us by nature as lazy as we dare be. With no encouragement on the part of his superiors, the young power plant operator takes the course of least resistance. The Police Gazette and Diamond Dick occupy the most conspicuous places on many of the operators' tables during the working hours.

The recent action of the officials of the Pacific Light & Power Company in supplying wholesome technical literature to all of their numerous power plants deserves more than passing notice. The striking thing that impresses one in entering any of their power houses is the ambitious and orderly group of young operators being reared in their employ. Upon the operating table may be found three or four of the very best technical magazines published. No other literature is to be found.

The result is that the young man, often having but a minute's leisure in his working hours, uses it in improving his general knowledge concerning technical matters. It is surprising how soon this encouragement on the part of the management shows itself in improving the efficiency of the entire power plant force. It is likewise surprising to see how rapidly such young men are enabled to advance over operators in other power plant installations where this encouragement on the part of the managerial forces is lacking.

This silent yet deep-felt influence will not be long in making itself felt in decreasing the depreciation factor and the general wear and tear of the power plant. A young man convinced of the sincere fatherly attentions of the company, responds wonderfully with every higher impulse in his nature. Let us hope that other power plant managers will early see the wisdom of such acts as this.

The paternal influence is keenly felt in every channel of daily life. Even old Noah Webster unconsciously sprung a human truth when he wrote his dry, staid dictionary, for in still further embellishing his definition of "pop" he said: "To pop the question, see pop."

It is a duty we owe to our profession—for every man is truly a debtor to his profession—to see to it that the young ambitious worker should receive the encouragement and nourishment necessary to lift him over the rough places and point the way ahead for more extended endeavor on the morrow.

Suppose, then, we all, while oiling up the machinery for another year's turn, resolve still further to sprinkle a little bit of oil of human kindness and assistance to those down at the first round of life's ladder, but who have their yearning gaze steadfastly upward and forward.

PERSONALS.

Ray D. Lillibridge, of New York City, is at San Francisco.

Thomas D. Petch, manager of the local lighting system at Medford, Ore., is at San Francisco.

J. C. English, who is a large dealer in lighting fixtures at Portland, is a San Francisco visitor.

Wynn Meredith, the Pacific Coast manager for Sanderson & Porter, is visiting the New York office of the firm.

W. T. Smith, manager of the Salt Lake City office of the Westinghouse Electric and Manufacturing Company, is at San Francisco.

H. L. Jackman manager of the Humboldt County interests of the Western States Gas & Electric Company, is at New York.

A. L. Searles, manager of the rock drill department of the Fort Wayne Electric Works, is at the San Francisco branch office on a tour of the Pacific Coast..

W. E. Barrett, gas engineer, with J. G. White & Company, of New York, is at Los Angeles, where he will spend some time in connection with new contract work.

H. C. Goldrick, Pacific Coast manager for the Kellogg Switchboard & Supply Company, of Chicago, will spend the next two weeks on a tour of Southern California.

H. R. Noack, president of Pierson, Roeding & Co., is making a business trip through the Pacific Northwest in the interests of the firm's various electrical agencies.

E. V. D. Johnson, manager of the Northern California Power Company, has arrived at San Francisco, where his office will be located in future instead of at Redding, Cal.

Sidney Sprout, consulting engineer for the Siskiyou Electric Light & Power Company, is on the Klamath River development, after spending a few days at his San Francisco office.

J. E. Crilly, and H. C. McCutchan, of the sales department of the Holabird-Reynolds Company, have returned to San Francisco after spending two weeks at the works of the Ohio Brass Company at Mansfield, Ohio.

James Churchill and Jesse Churchill, of Yreka, who are connected with the management of the Siskiyou Electric Power & Light Company, which is extending its system by constructing a hydro-electric plant on the Klamath River, are among the recent arrivals at San Francisco.

F. O. Dolson, electrical engineer with the Pelton Water Wheel Company, has returned to San Francisco from Bodie, after completing the installation of a 2500 h.p. Pelton water wheel at the Pacific Power Companys new electric power station, which supplies current for mines and towns in that district.

P. T. Hanscom, general superintendent of the Great Western Power Company, states that construction work was recently suspended for the winter at the site of the great impounding dam at Big Meadows. A construction plant of large capacity has been installed and work will be resumed early next season with a large force of men.

A. J. Myers, Pacific Coast district manager for the Wagner Electric Manufacturing Company, of St. Louis, has returned after visiting Los Angeles, to his San Francisco office which is now located on the ground floor of the Rialto Building. D. D. Wright, who is connected with the sales department, was in charge of the office during Myers' absence.

C. F. Flinn, electrical engineer, who was for some time connected with the sales department of the Allis-Chalmers Company's San Francisco office, has been made manager of all of the L. E. White Lumber Company's extensive interests at Greenwood, Mendocino County. A new power house, equipped with high-pressure marine-type boilers and a steam turbine generating set is to be constructed at the plant.

TRADE NOTES.

O. W. Lilliard, Pacific Coast manager of the Gould Storage Battery Company, with works at Depew, N. J., has removed his San Francisco offices to 902-904 Rialto Building, San Francisco.

The Bellingham & Skagit Railroad Company, Bellingham, Wash., has placed an order with the Westinghouse Electric & Manufacturing Company for four quadruple equipment No. 304 motors with type HL, USS control.

The Tulare County Power Company, through Purchasing Agent Holley, of Lindsay, California, has given an order for Locke insulators to equip 150 miles of transmission line to Pierson, Roeding & Company, and 110 tons of wire to the National Conduit & Cable Company.

The Hawaiian Electric Company, Ltd., Honolulu, T. H., representing the Westinghouse Electric & Mfg. Company, have sold a 125 k.v.a. non-condensing turbine with direct connected exciter and alternating current turbo-generator, 240 volt, 3-phase, 60 cycles, to operate at 3600 r.p.m., using superheated steam, also one three-panel switchboard complete with all meters and synchronizing apparatus. This equipment is for the Hawi Mill & Plantation Company's raw sugar factory. This plant will be operated in parallel with a 75 k.v.a water wheel driven generator 2¼ miles from the factory and delivering current at 2400 volts. Transformers at the factory will step the voltage down to permit of parallel operation with the new unit.

ELECTRICAL CONTRACTORS' NOTES.

Paul Butte returned from Portland after a two weeks' business trip.

Levy Electric Company have moved to a fine large store at 539 Market Street.

The John G. Sutton Company have been awarded the electrical work for St. Luke's Hospital, at approximately $15,000. L. P. Hobart is the architect.

Newberry, Benheim Company have opened a place in Chicago in charge of Mr. Benheim, who has had charge of the San Francisco and Los Angeles offices. In addition to the above places the firm have offices in St. Louis and New Orleans.

There is much speculation going on in reference to who will be the next chief of the Department of Electricity, and at present every one is guessing. The entire electrical fraternity should be heard from on this important subject, as there is no doubt that the incoming administration will be a business one and from no better source can a recommendation come than from the men whose business is practically controlled by the Department of Electricity. The contractors want a business administration and owing to the annoyances of changing administrations it is to be hoped that the Department of Electricity will be taken out of politics. In order to successfully perform the duties laid out for the department its chief should be a first class business man with good executive ability, have a thorough working knowledge of electrical construction and at all times be able to look at matters coming before him in such a manner as to know that the consumer has certain rights as well as the electrical tradesman, and at all times remember that "safety" is the watchword.

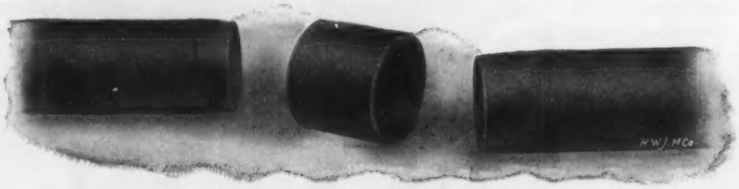
A GOOD IDEA FOR CONSULTING ENGINEERS.

William S. Turner, consulting engineer, Spalding Building, Portland, Oregon, is distributing a neat booklet which contains a summary of his professional experience and a list of the concerns for whom he has performed various classes of engineering work. This booklet is at once dignified and effective.

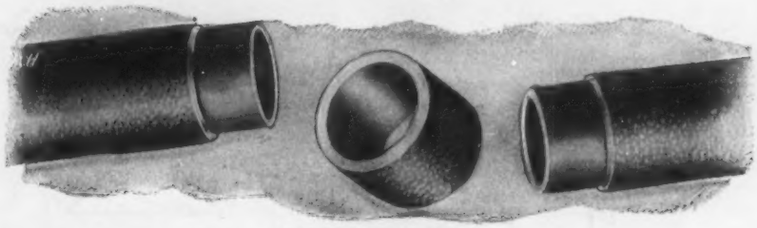
INDUSTRIAL

FIBRE CONDUIT FOR SUBWAY DISTRIBUTION SYSTEMS

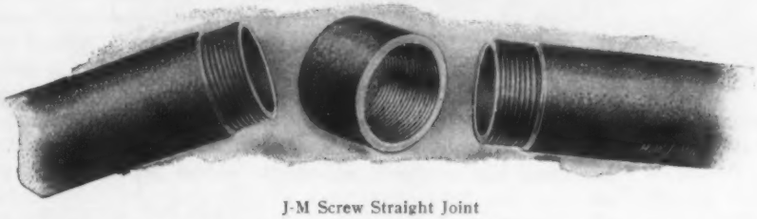
Fibre conduit is the most recent addition in materials for subway distribution systems that has been developed to meet the new conditions of service. It has been in use about eight years and is formed in cylindrical shape from fibre or wood pulp under pressure. The wood pulp is thoroughly saturated with a bituminous compound and any vegetable matter or bacteria which would tend to promote decay is killed by the presence of about 6 per cent of creosote salts in solution. There are at the present time two types in general use, known as straight joint and bell and spigot joint conduit, made in four styles of joint to meet the general conditions of service, namely socket (mortise and tenon) joint, sleeve joint, drive joint and screw joint, furnished in either 1 in., 1½ in., 2 in., 2½ in., 3 in., 3½ in. and 4 in. sizes. It has been shown that fibre conduit will stand an average puncture test of 32,000 volts dry and 24,000 volts after immersion in water for 200 hours.



J-M Drive Straight Joint



J-M Sleeve Straight Joint



J-M Screw Straight Joint

Screw Bell Joint

Sleeve Bell Joint

In the introduction of this material on the market there were objections to be overcome, the most serious being as to the life compared with the older styles of conduit which had been tried out, and during the eight years of development this point has been one of greatest discussion and observation, resulting in numerous laboratory and service tests. Samples recently excavated from the first installations show no deterioration, either mechanically or electrically, and while it is safe to say that fibre conduit will last indefinitely, no one is in position to tell whether impregnated fibre will last for more than fifty years, and in basing our calculations on the future, the only thing to do is to cite cases which are similar as possible.

It is a well known fact that objects have been disinterred and found to be wrapped in cloth saturated in asphalt, evidently having been buried for hundreds of years, the asphalt in the cloth showing no deterioration except to have become hard. Coal tar pitch and alleged wool felt, which is usually a combination of old rags, wood pulp, straw refuse, cotton and jute, was taken out of the subway which was built by the New York Central & Hudson River Railroad approximately 35 to 40 years ago, and found to be in perfect condition. However, there is no cause to wonder at this performance, simply because these bituminous substances preserve this material indefinitely when oxygen and the actinic rays of the sun are not a factor and destroying agent, and this is the case when a piece of conduit is buried in the ground. Furthermore, the creosote salts positively fumigate the material and stop mould and rot. There are roofs of buildings that have been subjected to oxygen and the actinic rays of the sun, made of bituminous compounds similar to that which is used for impregnating fibre conduit, that have given good service for more than thirty years. It is also a well known fact that railroad ties treated with an oil in which creosote occurs in sufficient quantity are immune to rot and decay and their life has not been determined, inasmuch as ties are now in service that were treated with carbolineum more than twenty-five years ago, and carbolineum is nothing more than creosote oil.

It has been found that about 90 per cent of all cable troubles are directly traceable to some injury to the lead casing when being drawn into the duct, due to the roughness of the walls, and the cement which has seeped through the joint and formed cutting edges after hardening. Cable troubles are also due to high currents leaking through the joints, as a result of improper installation and the impossibility of securing perfect alignment. These objections, however, are eliminated by the use of fibre conduit, due to the smooth interior and water-tight joints. Unlike joining tile conduit, the connection made with fibre conduit is ideal, affording perfect alignment without the use of mandrels or dowel pins, and not having to use cement, mortar or burlap at the joints.

It is also true that fibre conduit is impervious to moisture gases, acids or other corrosive elements, thus water, gas and stray currents cannot reach the cable protected by this

material. It is a good non-conductor, doing away entirely with the trouble with stray currents, and is also an absolute prevention against electrolysis, which destroys many cables, gas and water pipes during each year. It is known that a pressure of five volts will destroy a water pipe or cable in about nine years, and there are few railways, light and power companies, who have not been troubled with electrolysis. In the event of short circuit the wall immediately surrounding the arc may char but the fire will not spread, resulting in the easy removal of the cables from the ducts.

In figuring on subway installations, it has been fully demonstrated by experience of the largest operating companies that on account of the lightness in weight, large savings can be effected in freight, trucking, excavating, handling, laying and the amount of concrete necessary. In shipping and handling fibre conduit, breakage is practically nothing, due to the great tensile strength of the wall and the shock resisting properties of the material.

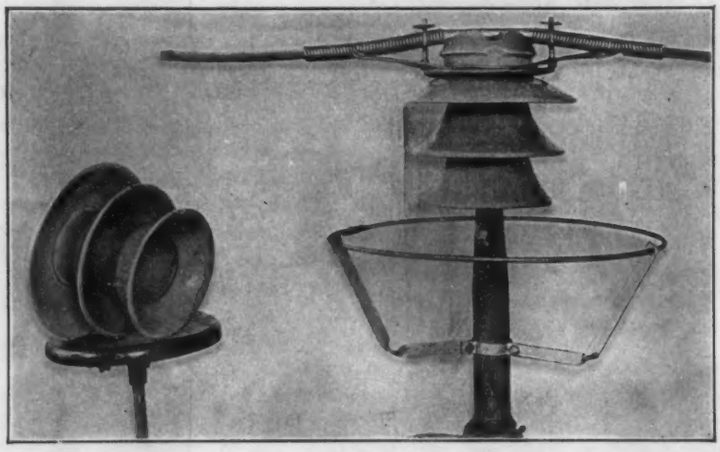
Socket Bell Joint

Samples of conduit which were placed in an oven and the temperature greatly raised show that at 135 degrees Fahr., softening of the compound began, and that at 205 degrees the compound became very soft, but the mechanical strength of the material was such that the samples retained their shape, and the effect was on the impregnating compound, only.

Fibre conduit has been known to withstand temperatures of 330 degrees satisfactorily. However, in actual service, the high temperatures named are not likely to occur, as the cable insulation would give way, and in giving these temperatures it is to illustrate the heat resisting qualities of fibre conduit under conditions other than normal.

THE NICHOLSON ARCING RING.

The Nicholson Arcing Ring which has been taken over exclusively for manufacture and sale by The Locke Insulator Mfg. Co. of Victor, N. Y., is apparently a near approach to the solution of much of the lightning trouble upon power transmission lines. Ordinarily, after a lightning storm, a lineman finds the insulator shot to pieces and it is usually construed as a punctured insulator. The fact probably is that due to an indirect stroke of lightning, that is to say, within a matter of a quarter of a mile or less of the line, surges have been induced upon the line causing the insulator to flashover and the power arc which follows, being an important power load being carried on a single circuit where the load cannot be transferred to a duplicate line. Or it is valuable again in the case of isolated, inaccessible portions of a line where repairs are laboriously and expensively made.



Nicholson Arcing Ring

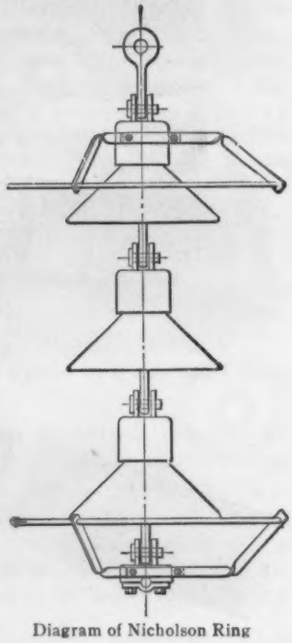


Diagram of Nicholson Ring

The most conspicuous example of the use of these rings has been in the case of the Niagara, Lockport & Ontario Power Company and Mr. Nicholson presented the features of this installation to the American Institute at the Charlotte meeting last year.

Very many ideas have been held regarding the service to be performed by high voltage insulators; some engineers intend them to serve as an absolute preventative of line discharges, depending upon lightning arresters and ground wires; others have considered making the insulator rugged enough to remain intact as a result of flashover, intending such line flashover to save destruction in the power house, but in no case has it been shown that it is safe to consider the insulators other than special pieces of apparatus which are in a sense frail and should be protected against destructive discharges as in the case of any other piece of apparatus.

Pierson, Roeding & Company of San Francisco, Portland, Seattle and Los Angeles, is the Pacific Coast representative for the Locke Insulator Mfg. Co.

SAFETY LIMIT STOP FOR ELECTRIC CRANES.

Those experienced in electric hoist or crane service know that with the ordinary limit switch which merely cuts off the current from the motor, the stopping point varies considerably. If the limit is set low enough to prevent dangerous over-travel of the hoist block when the hook is light and at high speed, a loaded hook coming up at slow speed will stop below the desired point. The drift of the motor and hook depends on the square of the hoisting speed and the load on the crane hook. Adjustment which suits one condition does not provide for all.

Palmer Safety Limit Stop.

The new Palmer Safety Limit Stop put on the market by The Cutler-Hammer Mfg. Company of Milwaukee will bring the hoist block to rest within two inches of any desired point regardless of whether the hook is light or heavily loaded, or whether the speed is high or low. This safety stop is not geared to the hoist nor operated by a traveling nut, but is operated by a trip rope. The motor circuit is opened and the series field connected across the armature when the hoist block reaches a predetermined point. The dynamic braking action brings the block to rest promptly. The device is enclosed in a substantial case and is made in capacities up to 25 h.p., 110 volts and up to 50 h.p., 220 or 550 volts.

IMPORTANT ANNOUNCEMENT.

On January 1st, 1912, the agency agreement for the sale of O-B overhead materials, rail bonds and car equipment specialties, which has been in force between The Ohio Brass Company, of Mansfield, Ohio, and the Pierson-Roeding Company, of San Francisco, for a number of years, terminates and will not be renewed, as it was mutually agreed that separate agency agreements for O-B hi-tension insulators and O-B electric railway equipment would eventually prove unsatisfactory and that the interests of all concerned would be better served by a single agency for the entire O-B line.

On and after January 1st, 1912, the Holabird-Reynolds Company, of San Francisco, who, for some time past, have been acting as exclusive agents for O-B hi-tension insulators only, will become the exclusive agents of The Ohio Brass Company for the sale of its entire line in the State of California.

The Holabird-Reynolds Company will carry an adequate stock of O-B railway materials and hi-tension insulators at San Francisco and business in Los Angeles and the southern part of the State will be handled by Mr. H. C. McCutchan of their Los Angeles office, under the personal direction of Mr. R. D. Holabird.

The business in the States of Washington, Oregon, Idaho, and in British Columbia will be in charge of the Company's own personal representative, Mr. F. V. Cook, who will make his headquarters in Seattle, at the office of the Holabird Electric Company. An intimate and friendly business connection between that comany and The Ohio Brass Company will be maintained because of their California Agency for O-B materials. Arrangements are being made to carry an emergency stock for quick delivery in Seattle.

Every effort will be made to handle all orders and inquiries in such a way as to merit a continuance of patronage and to render O-B service eminently satisfactory to Pacific Coast customers from every standpoint of price, delivery and quality of materials furnished.

ADVERTISING ELECTRIC VEHICLES.

A fund of at least $50,000 is being raised and will be expended by the Electric Vehicle Association of America, comprising central stations and the manufacturers of electric vehicles, batteries and accessories. The leading magazines, national weeklies and trade journals will be used for the publication of a series of convincingly worded advertisements, attractively illustrated to popularize the electric vehicle throughout the country. Articles along the same line, containing real news, will also be furnished these publications.

The advertising that has been done hitherto by manufacturers of electric vehicles has been selective advertising by means of which each advertiser hopes to cause the prospect to select his particular make. The Electric Vehicle Association believes that this national and general advertising campaign on the merits of the electric vehicle will make individual advertising of the same sort far more effective than it now is and largely reduce selling costs.

The members of the Association's Publicity and Advertising Committee, whose names guarantee that the advertising will be impartially conducted are as follows:

Charles: L. Edgar, chairman, Boston, Mass.; N. F. Brady, New York, N. Y.; G. W. Brine, Atlanta, Ga.; John A. Britton, San Francisco, Cal.; H. M. Byllesby, Chicago, Ill.; W. W. Freeman, Brooklyn, N. Y.; Frank W. Frueauff, Denver, Colo.; George H. Harries, Washington, D. C.; Charles R. Huntley, Buffalo, N. Y.; Samuel Insull, Chicago, Ill.; Arthur B. Lisle, Providence, R. I.; J. B. McCall, Philadelphia, Pa.; T. N. McCarter, Newark, N. J.; Alten S. Miller, St. Louis, Mo.; John B. Miller, Los Angeles, Cal.; R. F. Pack, Toronto, Ontario; Samuel Scovil, Cleveland, Ohio; R. M. Searle, Rochester, N. Y.; J. G. White, New York, N. Y.; ex-Officio W. H. Blood, Jr., President, Boston, Mass.

The prompt and generous co-operation of all interested in increasing the use of the electric vehicle is necessary to make this campaign the fullest possible success, and those who have not yet done so are urged to immediately send their subscriptions to Mr. W. H. Blood, Jr., president Electric Vehicle Association of America, 147 Milk street, Boston, Mass., who is personally supervising the raising of the advertising fund.

NEW CATALOGUES.

The General Electric Company has recently issued several interesting new bulletins. No. 4912 is devoted to ozonators for air purification; No. 4902 lists d.c. switchboards of 125 and 250 volts for controlling 3-wire generators; No. 4897 illustrates and describes G. E. Edison Mazda lamps for train lighting service; No. 4908 is devoted to the subject of lighting hotels, cafes and clubs, and No. 4895, which is attractively printed in colors, contains descriptions and illustrations of fans for use in the home, office and public places.

NOTICE OF ERRATA.

In the article on Storage Battery for Goldfield Mines, appearing in this journal of Dec. 30, 1911, the captions of Fig. 4 and Fig. 5, as well as Fig. 9 and Fig. 10, should be interchanged.

NEWS NOTES

INCORPORATIONS.

PRESTON, IDAHO.—Articles of incorporation for the Idaho-Utah Electric Company of this city have been filed at Boise. The company will provide power and light for Preston and other nearby towns.

BOISE, IDAHO.—Articles of incorporation for the Cleveland Construction Company, an electrical power and railroad corporation, have been filed here. F. A. Little of this city, has been designated as agent for the company, which is an Ohio corporation.

OLYMPIA, WASH.—Articles of incorporation for the Western Washington Water Power Company, incorporated at Portland, Me., November 10th, 1911, have been filed here. The officers of the company are Alvah Todd, president, and Clement Ford, secretary.

LAPWAI, IDAHO.—The Tom Beall Telephone Company has filed articles of incorporation and will construct a telephone line from Lapwai to Tom Beall Creek. Capitalization, $10,000. Incorporators are W. W. Olds, Dan Moore, J. W. Fenderson, J. J. Hogaboam, G. N. Elliott, D. G. Hogaboam and Ira F. King.

EL CENTRO, CAL.—Mt. Signal Water Company has incorporated with a capital stock of $125,000. The incorporators are F. A. Roeding, Manley Roswell, J. H. Lein, G. W. Nichols and S. A. Embury, all of El Centro. The plan is to undertake the project of bringing under irrigation about 25,000 acres of land on the west side of the Imperial Valley.

KIRKLAND, WASH.—The Kirkland-Redmond Railway, Light & Power Company of Seattle has filed articles of incorporation at Olympia. Capital, $200,000. Incorporators are C. A. Eaton, B. F. Gordon, Wm. Perigo, Samuel G. Hepler and W. D. Gillis. They propose to construct a railway between Kirkland and Redmond, and to erect a power plant at Kirkland.

ILLUMINATION.

TULARE, CAL.—An application from the Tulare Power Company asking the Board to advertise a franchise for sale, has been filed.

CHEHALIS, WASH.—The County Commissioners have granted a 50-year light franchise for Adna to the Washington-Oregon Corporation.

LOS ANGELES, CAL.—J. W. Carton & Company, contractors, are to furnish and install complete a power plant for the Beverly Hills Hotel, Beverly, Cal., for $10,775.

SANTA MONICA, CAL.—The warehouse of the Southern California Edison Company, located at Eighth and Colorado avenue, has been destroyed by fire, entailing a loss of about $35,000.

CHICO, CAL.—The Sacramento Valley Power Company, a new electric corporation, has been awarded a contract for furnishing electricity for street lighting purposes for the next three years, at a contract price of about $11,000.

SACRAMENTO, CAL.—Bids for the erection of a power house at the Southern California State Hospital were received by State Engineer Ellery. F. M. Walton of Hollywood, bid $11,445, and David Irvine of Riverside, $11,896.

KINGMAN, ARIZ.—The Santa Fe Company here is planning to install electricity in all buildings and yards of the company. Work is to start after the first of the year. The Desert Power & Water Company will supply the power.

DOUGLAS, ARIZ.—The Douglas Power Company will probably extend a power line from the county farm through the valley in the next few months. The merger of public utilities companies in Douglas means enlargement and improvement.

KLAMATH FALLS, ORE.—Messrs. Jesse W. and Jerome P. Churchill, Alex. J. Roseborough and Mr. De Trestain of the Siskiyou Light & Power Company, also owners of the Klamath Light & Water Company, have asked for a light and water franchise.

CATHLAMET, WASH.—M. Haycox of Portland is seeking a franchise for an electric light plant here, and the construction of a dam in Elocoman River. The proposed plant will cost $15,000. The application will come before the town council in January.

YUBA CITY, CAL.—The Live Oak & Encinal Light & Power Company, which for several years has been supplying the town of Live Oak and vicinity and the country south of town as far as Encinal, have gone out of existence, and the Pacific Gas & Electric Company has taken control.

PORT TOWNSEND, WASH.—With the old year the coal oil lamp at Fort Flagler has disappeared and its place taken by an electric signal, as a result of the completion of a power plant at that fort. The wires for lighting the various buildings, streets and parade grounds are laid under ground, 100 c.p. lights being used for illuminating the streets and parade grounds. Forts Worden and Casey have been lighted with electricity for some months. In addition to the lighting plants all three forts have been equipped with searchlights and such stations extend from the forts several miles along the shore line at stated distances apart.

GLENDALE, CAL.—The new street system for Glendale includes the construction of five light iron standards constructed every 100 feet along each side of Fourth street from Central avenue to Everett street, on Brand boulevard from Third street to Sixth street, and along Glendale avenue from Third street to Fifth street. After the improvement is completed the maintenance of the lights will cost the city of Glendale about $100 a month. In connection with this improvement the Pacific Telephone and Telegraph Company is putting all of its lines along the streets to be improved, under ground, so as to do away with the large number of poles now standing along the streets.

TRANSPORATION.

MODESTO, CAL.—Preliminary work on the Stanislaus River bridge for the San Joaquin Valley Electric Railroad has been awarded to the Pacific Construction Company.

SACRAMENTO, CAL.—The bid of the Sacramento Electric, Gas & Railway Company for annexed territory was accepted and the ordinance passed, granting the franchise.

LOS ANGELES, CAL.—The one offer made for the electric railway franchise along Washington street easterly from Pasadena, was by the Pacific Electric Company, at $100, and was accepted. Work will start at once.

LOS ANGELES, CAL.—The $5000 bid of the Los Angeles Railway Company for the crosstown car line franchise under which lines will be established on Jefferson street, Vernon avenue and Vermont avenue, was accepted.

EMMETT, IDAHO.—The Idaho-Oregon Light & Power Company will build a 112 ft. dam in the Black Canyon of the Payette River, about 6 miles above here, in the near future. Cost will be $250,000.

EL CENTRO, CAL.—Five carloads of machinery for the producer gas electric power plant of the Holton Power Company, have arrived. This shipment includes the huge generator, and the gas-producer engine.

CALISTOGA, CAL.—J. T. York of Napa his asked for a franchise for the San Francisco, Napa & Calistoga Electric Railroad Company, to run their line into the town of Calistoga. An adjourned meeting will be held to settle the matter.

CALISTOGA, CAL.—Superintendent M. McIntyre and Attorney John T. York of the San Francisco, Napa & Calistoga Railway, appeared before the town board on Tuesday and applied for a franchise to run the electric cars upon the streets and thoroughfares of Calistoga and the request was granted.

PASADENA, CAL.—A compromise has been reached between the City Council and the Pacific Electric Railway concerning the franchise for a car line out Washington street. The line will be built, opening to transportation the northwest section of the city and Nazarine University. The franchise has been amended to read 19 years.

SACRAMENTO, CAL.—The Northern Electric has closed a lease for operation of the Sacramento-Woodland electric line as soon as the road is completed. The lease will extend until the company can secure its rolling stock and provide an operation department. The Sacramento-Woodland line will cross the tule land on a trestle 8800 feet long that is under construction. One hundred cars of steel rails are on the way to this city from Pittsburg for use in building the line.

BERKELEY, CAL.—Beginning December 31, all Southern Pacific local trains running into Berkeley were electrically propelled. For some time, partial electric service has been in vogue on the Shattuck avenue line, steam trains being run during the hours when the traffic was the heaviest. Another large residential district is afforded through train and ferry service by the opening of the new Ellsworth street line from the Oakland mole to Allston way, near the entrance to the State University.

SEATTLE, WASH.—The name of the Seattle-Everett Traction Company has been changed to the Pacific Northwest Traction Company and the Seattle-Everett system and the Bellingham-Ekagit line, now under construction, have been brought into one corporation under the new name. The Pacific Northwest Traction Company is capitalized at $3,500,000. Questions of economy and convenience in operating the Seattle-Everett line and the Bellingham-Skagit line were responsible for the merger of the two systems and the adoption of one name for the consolidated line.

SACRAMENTO, CAL.—The Oakland, Antioch & Eastern Railway Company has applied for franchises to operate interurban electric trains into this city across the Sacramento River and through several of the streets, some of which are already occupied by interurban and street car franchises. The road will enter the city from the west over a big steel bridge now being constructed by the Northern Electric, Vallejo Northern and Sacramento-Woodland electric lines, and will build down the west side of the Sacramento River through the reclamation districts of Yolo County.

TELEPHONE AND TELEGRAPH.

KENNEWICK, WASH.—Manager A. F. Brown of the Kennewick Valley Telephone Company, announces that $6000 will be expended in improvements. A modern common battery system will be installed, thus doing away with the present "ringing-for-central" method.

PORTLAND, ORE.—The Home Telephone & Telegraph Company has filed a suit in the United States Circuit Court against the City of Portland to restrain it from interfering with the operation of its business and the recovery of such damages as the court may determine. The complaint alleges that the servants of the defendant city have threatened to enforce against it ordinance No. 19626, which refers to the stringing of wires and erection of poles, that if enforced would cause the plaintiff great expense and annoyance. It is also alleged that no other company operating wires and poles in the city has been subjected to this ordinance, although it was passed June 1, 1909.

WATERWORKS.

PASADENA, CAL.—The proposition of voting $40,000 for the purchase of a reduction plant, will be settled Feb. 7.

ELMA, WASH.—The contract for the construction of a water system has been awarded to Welton, Kibbe & Cochran of Portland, Oregon.

HUNTINGTON PARK, CAL.—Three proposed bond issues have been defeated; $60,000 for a water system, $40,000 for an electric plant, $10,000 for fire protection.

FALLON, NEV.—Sealed bids will be received up to January 17, and at that time publicly opened and read for the materials and construction of a complete waterworks system.

ELLENSBURG, WASH.—It is believed that the contract for the construction of the municipal waterworks system will be awarded to the International Contract Company of Seattle who offers to do the work for $122,280.

SPOKANE, WASH.—Plans for the $200,000 high pressure water main system for better fire protection in the downtown district have been forwarded to Special Agent McKenzie, representing the Board of Fire Underwriters for Washington.

SUTHERLIN, ORE.—An ordinance authorizing the Common Council of the city to construct and maintain a system of waterworks and providing for the issuance of bonds for $30,000 for providing funds therefor, will be voted on at the next election.

SAN FRANCISCO, CAL.—The Board of Public Works has advertised for bids for work which includes the general construction of the second pumping station of the salt water fire system for Fort Mason Reservation; the structural steel for the same and the mechanical equipment for the building.

TACOMA, WASH.—Two additional springs will be tapped at the headworks of the municipal water plant by a project now proposed by Councilman S. W. Greenwood and Water Superintendent C. S. Watters. The plan is to lay a 12 inch pipe around the base of the hill, tapping the two springs now being used.

REDMOND, ORE.—The Council has passed an ordinance providing for the issuance of negotiable coupon bonds of the city in the aggregate amount of $27,000 for the purpose of acquiring waterworks. The bonds to consist of 27 in number in the denomination of $1000 each, numbered consecutively from 1 to 27, both inclusive, payable in the order of their number as specified. Rate 7 per cent per annum, payable semi-annually on the 1st of May and November of each year.

EXETER, CAL.—The following bids for the water plant of this city were received: C. D. Vincent, $31,595.25; Chambers & Healy, $31,995; Western Engineering & Construction Co., $32,363.10; Central California Construction Co., $32,910.05; C. F. Braun, $32,100 Henry R. Worthington Co., pumping station only, $3675; Smith, Booth, Usher Co., tanks and towers only, $3978.30; Byron Jackson Pump Co., by J. M. Peck, station only, $3978.30. The contract was awarded to C. D. Vincent of Oakland.

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